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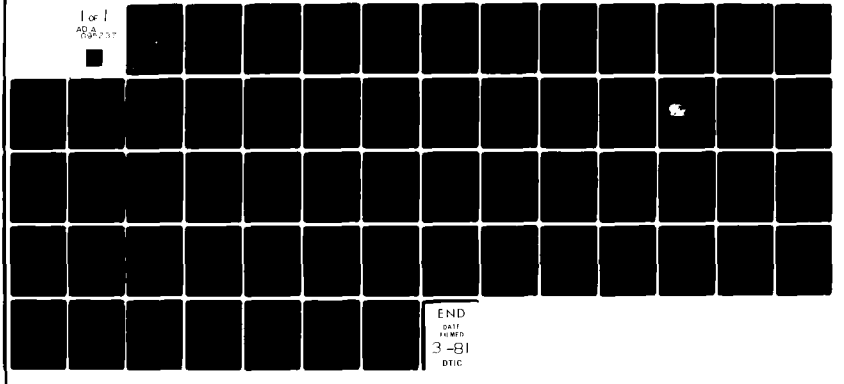

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This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the Scientific Literature) may prove of value to American scientists by calling attention to current developments and to institutions and individuals engaged in these scientific efforts.

The articles are written primarily by members of the staff of ONRL and occasionally articles are prepared by, or in cooperation with, members of

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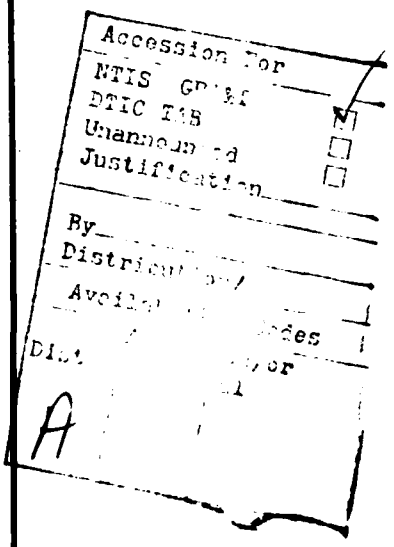

EUROPEAN SCIENTIFIC NOTES
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Edited by John R. Neighbours and Don J. Peters

31 December 1980 Volume 34, No. 12

NEWS and NOTES

ONRL REPORTS

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W.J. CONDELL
Chief Scientist

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Captain, USN
Commanding Officer

AUTOMATION

INORGA—THE INSTITUTE OF INDUSTRIAL MANAGEMENT AUTOMATION IN PRAGUE

For reasons which seem to be unknown even to its director, the Institute of Industrial Management Automation is known throughout Czechoslovakia by the acronym INORGA. The institute belongs to the Ministry of Metallurgy and Heavy Engineering and reports directly to the Minister, Josef Kriz, who is, of course, a politician. On the other hand, INORGA's director, Peter Cáslavský, and vice-director, Dr. Chladek, are technically trained. Other ministries have their own institutes, some of which do comparable work, and the Ministry of General Engineering, in particular, has an institute, codenamed ORGAPROJEKT, which is very similar to INORGA. INORGA and ORGAPROJEKT sometimes let subcontracts to one another when one has too many contracts and the other does not have enough.

INORGA was established 14 years ago, specifically to provide skilled assistance in computerizing and automating the factories under this Ministry and to act as a computer center for the Ministry. At the present time it has a wider field of computer application, including production-process control, with complex design and implementation of computer management and control systems. Its headquarters are at Letenska 17, in downtown Prague, but it also has specialized branches near the major steel-producing locations at Brno, Ostrava, and Košice. The full organization, including all branches, has about 410 people, of whom about 260 are professional. This is a typical example of the low (and, in my opinion, inefficient) ratio of support personnel to professional personnel, which is so common in the socialist countries.

This staff is not nearly large enough to do everything that has to be done in all of the factories that come under the Ministry, and INORGA concentrates its efforts wherever it can sell them; that is, there is a transfer of money from the books of the factory where INORGA works to the INORGA books to support the INORGA personnel who work on a project, and these projects must be sold, very much, I suspect, as they are in the US. However, I was told that the director and vice-director are very little involved in this marketing effort; rather, each division-head does his own selling.

The institute comprises 9 divisions, 3 of which are administrative, and 6 technical. Three of the technical divisions are located at the above-mentioned outlying industrial centers; the remaining 3, situated in Prague, are associated with particular levels, namely the ministerial, enterprise, and process levels. I was particularly surprised at the implementation of what they call the ministerial level, which involves the development of computerization of ministerial decision making. They now have a well-developed information system and data base with 36 terminals in the Ministry itself. Even the Minister has a terminal in his own office, and uses it!

Most of the work in INORGA is highly applied. Thus, while many of its personnel are systems analysts, computer programmers, and the like, who know quite a lot of mathematics, there are virtually no professional mathematicians. The INORGA personn are responsible for the development of software and for the implementation of programs. They are little involved with hardware, although an individual factory could not purchase a computer without the approval of the Ministry, and that approval would not be likely to be granted until INORGA had been consulted. INORGA is also responsible for the coordination of developmental efforts. If, for example, a particular company developed a computerized, materials-requirement-planning system, it would be up to INORGA to know which other companies, if any, with similar requirements could use it. In order to spread the word to the companies, INORGA runs seminars sponsored by the Ministry to which people from the various factories under the Ministry are invited.

Miroslav Knotek, who formerly headed one of the technical divisions, has recently become the head of one of the administrative divisions, namely the Research and Development Division, which also includes planning. Working with him is Jan Kroužek, who took his engineer's degree in Prague and has done postgraduate work at Imperial College in London. I asked Kroužek for some success stories, to give me an idea of how INORGA operates at its best. Apparent the institute's most successful work has been done for the Skoda automobile factory, where INORGA personnel developed an integrated production-control system, including shop-floor control, production planning and scheduling, production reporting, assembly-line balancing, etc. This was accomplished by a team of some 10-12 people from INORGA, plus people from Skoda's computer department, over a period of about 6 years. The project is ongoing, and they are still maintaining and changing programs ("one is never finished with such a job," Kroužek told

me), but the result has been an increase of almost 100% in production over the 6 years and "Skoda can stack up well now against other European companies." An almost equally successful implementation of automation was made at the Poldi steel works in Kladno. This is a company which has had a fine reputation since the 19th century and is now a major supplier of high-quality, high-alloy steels. The system at Poldi includes production reporting, cost analysis, order handling and processing, capacity loading, production scheduling, material-flow control, and process control. Process control in particular applies to the furnaces, where there must be complex types of smoothing to avoid price penalties for the use of excessive amounts of electrical current. Similar work has been done in other factories, although generally not with quite so much success.

One large effort which has been emphasized in recent years is the link between maintenance and production. It is well known that preventive maintenance is often much cheaper than repair, but there is frequently disagreement between the production manager, who wishes to keep production going, and the maintenance manager, who wishes to stop it to perform his preventive maintenance. INORGA people have built models and done simulations to reconcile and coordinate these differing tendencies. In particular, they have written extensive simulation models to evaluate alternative maintenance plans. They formerly wrote such models in the GPSS language, but have now substituted SIMULA 6 which they find more flexible and faster. Most of these simulations are run on an IBM 370/145 at the ministry. The technical people at INORGA with whom I spoke were quite positive about the necessity of using American computers. They had tried Russian computers and simply found them unsatisfactory.

Not all of the work of the Institute is quite so applied as the above. For example, I talked to a young man named Václav Gafron, one of a group of 3 engaged in a 4-year task to write a new language for numerically controlled machine tools. INORGA, of course, writes the programs for all such tools, and it is hoped that this language, when completed, will allow the programming of such tools to be done much more efficiently.

Knotek assured me that INORGA had achieved international recognition. He told me of a 7-man group from Czechoslovakia which is now at the steel mills at Annaba, in eastern Algeria, helping to develop greater automation and better control there. Five of these people are from the steel companies and two are from INORGA. The Complex Automation Institute in Moscow has utilized some of INORGA's simulations, and INORGA people have been working in Moscow to help set these up. In addition Knotek informed me that INORGA is negotiating with some US companies for program packages which they have developed. I find these assertions believable. The people in INORGA seem highly competent and the automated systems in the metallurgical and heavy engineering plants in Czechoslovakia do indeed seem to be working with considerable efficiency. (Robert E. Machol)

CHEMISTRY

THE 31ST MEETING OF THE INTERNATIONAL SOCIETY OF ELECTROCHEMISTRY

This conference was held amidst the elegant surroundings of the Giorgio Cini Foundation on the island of San Giorgio Maggiore in Venice, Italy, from 22-26 September 1980. San Giorgio is a relatively small island which lies directly across the Canale di San Marco from St. Mark's Square. The original church, which was dedicated to St. George and from which the island takes its name, is generally believed to have been built in 790 AD. In 982 AD the first Benedictine monastery was founded on the island. The buildings of the former monastery which stand today were built in the 1500s. The monastery and the island itself had fallen on hard times and suffered from neglect. However, in 1951 the Giorgio Cini Foundation was able to obtain the concession of the island for the purpose of restoring the historic buildings and founding social, cultural, and artistic institutions there. Since the restoration of the former monastery, the island of San Giorgio has been the site for numerous international meetings including the Economic Summit Conference of the heads of the Western governments held in the summer of 1980.

The main lectures of the conference were given in the Palladian Refectory and in the very impressive Hall of Tapestries. As there are no hotel facilities on the island of San Giorgio, the 550 participants representing 39 countries stayed on the main island of Venice. Transportation between the conference site and Venice was provided by the organizers in the form of free vaporetto (boat bus) service. This service was frequent and convenient departing from "Monumento" near St. Mark's Square during the morning and late afternoon. It should be noted that the island site for the conference served somewhat to isolate the participants thereby reducing the temptation to "play hooky"

from the scientific sessions to tour the magnificent palaces of Venice and the glass factories of Murano. The organizers were also able to arrange for a ballet in the beautiful Teatro La Fenice.

The International Society of Electrochemistry (ISE), which traces its origin to the International Committee on Electrochemical Thermodynamics and Kinetics (CITCE) founded in 1949, was incorporated in 1971. The ISE, an associated organization of the International Union of Pure and Applied Chemistry, not only organizes international conferences, but also edits its official organ, *Electrochemica Acta*, a widely respected journal devoted to the field of electrochemistry.

The meeting was organized into 28 invited lectures of 30 to 50 minutes duration for the morning sessions with the afternoons devoted to 4 or 5 parallel poster sessions with over 300 contributions. It was observed that the lectures and the poster sessions were well attended throughout the week. There was a relatively unsuccessful attempt at providing open discussion of posters by scheduling meetings late in the afternoons following the poster sessions. With the exception of the welcoming session with introductory remarks from the Mayor of Venice and officials of the Universities of Padua and Venice, the language of the conference was English. For the opening session translation of the welcoming remarks was provided.

The conference had two main themes: (1) electrocatalysis and chemisorption, and (2) generation and role of electric potentials in biological and model membranes. The second topic was organized in collaboration with the International Group on Bioenergetics. In addition to the invited lectures and posters related to the main themes, contributions were also presented in the following areas: (1) thermodynamic and structural aspects of electrolytic solutions in mixed solvents; (2) optical and spectroscopic methods of investigation of the electrodic interphase structure; (3) kinetics of elementary steps and intermediates in electroorganic processes; (4) nonaqueous and miniature electrochemical cells; (5) accelerated corrosion testing with electrochemical methods; and (6) modern concepts in electrochemical reactor design. There were many excellent lectures and poster papers presented; unfortunately, this observer can provide only a small sample of the papers.

Prof. Ernest Yeager (Case Western Reserve Univ.) led off the Monday morning session with a lecture on oxygen electrodes and electrocatalysis. He emphasized that electrocatalysis and chemisorption were basic to most electrochemical processes. In his lecture Yeager focused attention on the cathodic reduction of O_2 to water, a process which he noted is of considerable importance with respect to fuel cells and metal-air batteries. A summary of the two pathways by which the reduction is usually considered to proceed was given: (1) the peroxide pathway involving an initial two-electron reduction of oxygen to peroxide followed by either electrochemical reduction of the peroxide to hydroxide or the catalytic dismutation of the peroxide to hydroxide and oxygen, and (2) the direct four-electron pathway involving a series of reduction steps of oxygen to hydroxide or water without peroxide being produced in the solution phase. Yeager noted that catalysts which promote the peroxide path 1 include carbon, graphite, and gold in alkaline electrolytes, while a clean platinum surface and adsorbed transition metal macrocyclics such as iron tetrasulfonated phthalocyanine tend to favor the four-electron pathway 2. Yeager discussed the requirements for effective four-electron catalysts in terms of the theoretical models for the interaction of molecular oxygen and related oxygen species with adsorption sites.

Prof. J.M. Saveant (Univ. of Paris VII) delivered a lecture on the catalysis of chemical reactions by electrodes, i.e., the catalysis of a chemical reaction that proceeds slowly under normal thermal conditions but is accelerated in the presence of an electrode that is maintained at a suitable potential. Electrocatalysis results from the fact that an oxidized or reduced species is more reactive than the original reactants. Saveant discussed the electrochemical catalysis of the aromatic nucleophilic substitution of 4-bromobenzophenone by thiophenoxide. The catalytic nature of the process was shown by a 4:1 ratio for the moles of product formed relative to the number of faradays required. He also pointed out that the sum of the processes occurring at each of the electrodes in any electrochemical cell can be considered as adding up to a balanced overall chemical reaction. If a reaction is endothermic, the electrolysis will involve the conversion of electrical energy into chemical energy in a process that is actually electrosynthesis. If, however, a reaction is exothermic but proceeds slowly because of activation barriers, electrochemical catalysis of the reaction may be possible. An actual electrocatalytic situation is obtained when the number of faradays required to drive the reaction to completion tends toward zero. This lecture provided an excellent review of electrocatalytic processes and offered insight into the design of synthetically useful electrocatalytic reactions. In his lecture Saveant treated various examples

and discussed approaches to the minimization of competing side reactions which serve to lower the catalytic efficiency of the reaction. The use of cyclic voltammetry in testing the feasibility of new electrocatalytic reactions, and in selecting optimum operational parameters, was discussed.

Prof. W.J. Lorenz (Univ. of Karlsruhe) presented a lecture on the determination of corrosion rates by electrochemical techniques. He pointed out that direct analytical methods for measuring metal corrosion such as weight loss or spectroscopic measurements require relatively long corrosion times for the corroding specimens. He further emphasized that direct methods are applicable only to systems that do not form adherent layers of corrosion products on the corroding metal surface. A more rapid method is obviously desirable and various electrochemical techniques are currently being investigated for accelerated corrosion testing. He noted that the electrochemical nature of corrosion processes made the determination of corrosion rates by indirect electrochemical methods feasible with the attendant advantages of relatively short corrosion times, high accuracy, and the possibility of continuous corrosion monitoring. A major disadvantage of electrochemical methods seems to be that the electrochemical measurement itself perturbs the system with possible resultant changes in the properties of the system such as the structure of the surface. Lorenz reviewed the three types of electrochemical corrosion rate measurements which were classified according to the parameters that are used for the evaluation of the corrosion rates: (1) determination of the corrosion current density at the corrosion potential obtained by extrapolation of anodic or cathodic Tafel lines of charge-transfer controlled corrosion rates, (2) polarization resistance (R_p) from DC-measurements or AC-impedance measurements, and (3) determination of charge-transfer resistance (R_t) by AC-impedance measurements and pulse methods. Lorenz stated that good agreement is often obtained between corrosion current density measurements and weight loss in systems exhibiting uniform metal corrosion in acidic media. However, in corroding systems containing oxygen in weak acid, neutral, or basic solutions, the corrosion current density can be determined by oxygen reduction processes leading to oxidative corrosion products on the surface. Under these conditions comparison of the electrochemical and analytical measurements can be difficult. Lorenz indicated that major changes in the properties of the corroding system are less of a problem with polarization measurements than with current density measurements. For this reason most commercial corrosion testing instruments utilize the polarization approach to corrosion testing. Factors that influence polarization measurements were discussed. He compared the results obtained by various electrochemical techniques to analytical data and cautioned that electrochemical methods must be used carefully with a fairly complete knowledge of system-specific corrosion behavior. In particular, the presence of corrosion inhibitors with the associated adsorption-desorption processes can affect the results of electrochemical measurements.

Prof. M. Keddam (Univ. of Pierre and Marie Curie, Paris) also discussed the application of AC-impedance measurements to the determination of corrosion kinetics. He compared the results of these measurements to analytical data with both inhibited and noninhibited iron. Considerable discussion by the participants followed this lecture in which it was stressed that reliance on only one electrochemical technique such as R_p (DC- or AC-impedance) measurements may lead to erroneous conclusions concerning corrosion rates. There was general agreement, however, that DC polarization resistance measurements in general correlate better with weight loss than AC models.

Dr. F. Mansfeld (Rockwell International Science Center) presented a review of electrochemical techniques for the determination of the susceptibility of materials and alloys to atmospheric corrosion phenomena.

Prof. G. Mengoli (Univ. of Padua) discussed their recent work on the formation of protective polymer coatings on Fe, Zn, and Cu by electropolymerization. He described the process as one in which the metal sheet or object to be coated is immersed in an electrolysis tank containing a monomer solution. Application of a constant voltage results in the formation of a polymer film on the metal surface. He noted that the experiments with simple vinyl and acryl monomers have proved generally unsatisfactory with poor coatings and propagation of the polymerization into the solution. Mengoli's work has recently involved the oxidative polymerization of phenolic compounds in various media including alkaline water, melted phenol, and aqueous alcohol solution to give polyoxyphenylene coatings on the metal anodes. He described the results of work with the electropolymerization on iron of *o*-chlorophenol in 25% aqueous methanol in the presence of NaOH and ethylenediamine. Coatings obtained from this mixture were found to exhibit good salt fog resistance

and adhesion, but with relatively poor elasticity. In the absence of the amine additive, very unsatisfactory coatings were obtained. Mengoli believes that the function of the amine is primarily to retard the formation of passivating metal oxides during the electrolysis which would inhibit polymer growth. It has been found that thick homogeneous coatings are obtained only when an amine is present in the electrolytic medium. However, mass spectral data of these coatings indicate that the amine is also contained in the structure of the polymer. Mengoli reported that a variety of phenol/amine combinations were screened for effective coating formation. The best coating to date which these workers have found utilized *o*-allylphenol and allylamine. He indicated that only 4 to 5 minutes are required for the formation of a good coating under their experimental conditions. The protection afforded a metal plate compares favorably with that obtained by electropainting, with good salt fog resistance, adhesion, scratch resistance, and elasticity. Thicknesses up to 18 μm were obtained. Samples of metal plate that had been coated by this process were exhibited. Another system which seems to hold considerable promise is methanesulfonanilide and allylamine.

Prof. B. Scrosati (Univ. of Rome) provided a review of nonaqueous primary electrochemical cells such as the solid electrolyte Li/I_2 cell, the organic electrolyte Li/Ag_2CrO_4 and Li/CuS cells, and the Li/inorganic electrolyte cells with attention to discharge behavior, reliability, and state of development. Recent developments in rechargeable batteries were described including Na/S solid electrolyte batteries, Li/metal sulfide fused electrolyte batteries, and Li organic electrolyte batteries. The improved performance of reversible cells that can be obtained by using intercalated electrodes was described.

Prof. A. Girlando (Univ. of Padua) reviewed progress in the use of Raman spectroscopy for the characterization of molecules adsorbed on electrode surfaces. This spectroscopic method is particularly attractive because vibrational Raman spectroscopy not only possesses a high degree of molecular specificity, but it can also be adapted for *in situ* studies. Although the Raman signal obtained from a monolayer of molecules on a surface is often too weak to be detected, certain molecules on certain metal surfaces exhibit a Raman effect which is enhanced by a factor of 10^4 to 10^6. This effect, which has been identified as Surface Enhanced Raman Spectroscopy (SERS), is proving very useful in the characterization of molecules on electrode surfaces.

Dr. D.M. Kolb (Fritz Haber Inst., Berlin) presented a lecture on recent advances in the use of spectroscopic method to probe the nature of the electrode-electr lyte interface. He discussed results obtained with single crystal noble metal electrodes by electroreflectance, a technique that involves monitoring the changes in reflectance upon varying the electrode potential. Also reviewed was the use of surface plasmon excitation as a method for *in situ* studies of the interface.

Among the 32 poster papers that were presented in the area of accelerated corrosion testing with electrochemical methods was a description by N. Azzerri, R. Bruno, and L. Splendorini (Rome) of their work on the measurement of corrosion rates of steel in natural sea water by polarization resistance techniques. The electrochemical data were in good agreement with weight loss measurements. O. Lunder, K. Nisancioglu, O. Hunderi, and H. Holtan (Trondheim-NTH, Norway) described a technique for quantifying the physical changes that occur on a metal surface as a result of corrosion. Diffuse light scattering is used to measure the growth of pits or the increasing roughness of a surface. These corrosion tests were carried out on several different aluminum alloys.

In the area of nonaqueous electrochemical cells, a collaborative investigation by F. Bonino and M. Lazzari (Milan, Italy) and M.J. Smith, C.A. Vincent, and A.R. Wandless (Fife, Scotland) has been conducted on intercalation electrodes for solid state cells. Diffusion coefficients of silver in hosts such as TaS_2, TiS_2, and NbS_2 were measured by use of chronopotentiometric relaxation techniques. J. Bressan, A. de Guibert, and G. Feuillade (Marcoussis, France) have investigated the voltage delay or drop associated with $Li/SOCl_2$ cells. This voltage drop which occurs upon initiation of the discharge of the battery seems to be due to a passive layer of LiCl that is formed on the Li electrode. These workers have studied the influence of various compounds in the electrolyte on the voltage drop. Significantly, it was observed that in the presence of PCl_5, BCl_3, or $SiCl_4$ the voltage drop is not observed. Further the authors report that the lithium electrode seems to keep its metallic appearance rather than becoming dull as it does with $AlCl_3$ or $SbCl_5$.

The 32nd meeting of the International Society of Electrochemistry will be held from 13-20 September 1981 at the Hotel Croatia in Cavtat near Dubrovnik, Yugoslavia. The main themes of the meeting will be: (1) fundamental aspects of electrochemical energy conversion, and (2) metal deposition and dissolution. Additional information concerning this meeting can be obtained from Prof. B. Lovrecek, 32nd ISE Meeting, P.O. Box 840, 41001 Zagreb, Yugoslavia. (A. Paul Schaap)

DISCUSSION CONFERENCE ON POLYMER NETWORKS, KARLOVY VARY, CZECHOSLOVAKIA

The recent meeting on polymer networks in Karlovy Vary was part of the now well-established series of conferences on macromolecules held in various locations in Czechoslovakia. Its official designation was the Seventh Discussion Conference on Macromolecules; its sponsors were the International Union of Pure and Applied Chemistry, Czechoslovak Academy of Sciences, and Czechoslovak Chemical Society; and the Conference Chairman was Dr. K. Dusek (Institute of Macromolecular Chemistry, Prague).

Karlovy Vary (alias Karlsbad) is a delightful little town approximately 130 km west of Prague. It is known primarily as a health resort or spa, where copious amounts of the naturally occurring hot mineral waters are drunk to effect a variety of therapies and cures. The scientific meeting was held in the Sanatorium Thermal, a very modern building and probably the newest in this historic old town, from 15 through 18 September. Approximately 125 scientists from 18 countries attended the conference.

The main lectures on the first day were devoted to gelation theory, which is of course of direct relevance to the formation of polymeric network structures. Prof. M. Gordon (Univ. of Essex, UK) gave what was essentially a unifying lecture, which was generally quite successful in reconciling two competing theoretical approaches to critical phenomena such as gelation. The first (and much earlier) approach is based on the classical mean-field theories, whereas the other relies on the newly developed scaling or percolation theories. Both were judged to be equally valid and capable of meaningful refinement, and simply different but equivalent ways of looking at the same problem. Prof. D. Stauffer (Univ. of Cologne, FRG) presented his theory of gelation in the following lecture, including analytical results and results written as a series of expansions, and their comparisons with Monte Carlo simulations. In contrast to Gordon, he strongly advocates use of the percolation theories. He cited as important unsolved problems the investigation processes which involve one, or a combination of, the following characteristics: they are nonrandom, continuum based, or time dependent. The third and final lecture of the day was presented by Dr. M. Adam (CEN-Saclay, Gif-sur-Yvette, France). It consisted primarily of experimental results on the viscosity of sol phases and the elasticity of gel phases near the critical point. Some results favored one theory and some the other, but overall agreement seemed to be better for the mean-field approach.

The second day dealt primarily with the preparation and investigation of "model" elastomeric networks, i.e., those prepared by very specific chemical reactions so as to provide independent information on the network structure, in particular the number of functionality of the crosslinks. The lecture by Prof. J.E. Mark (Univ. of Cincinnati, USA) showed how model networks can be used to resolve important issues in the area of rubberlike elasticity. Specific examples were characterization and interpretation of the effects of limited chain extensibility and dangling chain ends, and the properties of networks which are very heterogeneous (compositionally and spatially) with regard to chain length distribution. Prof. C.W. Macosko (Univ. of Minnesota, USA) spoke extensively on experimental difficulties encountered in making model networks, specifically problems in carrying out the desired chemical reactions essentially to completion. He suggested that many model networks may be incompletely crosslinked, and that one could correct for this deficiency using sol fraction data. This would give relatively large values for the elastic modulus for such networks, and the increases above the theoretically expected values could then be interpreted in terms of contributions from "trapped interchain entanglements." Experimental results presented in the lecture by Dr. W. Oppermann (Univ. of Clausthal, FRG) seemed to contradict the Macosko analysis in that some model networks having very low sol fractions were found to also have low moduli, which is in at least qualitative agreement with some similar results reported by Mark. Thus, there is still considerable disagreement with regard to whether or not chain entanglements contribute significantly to the equilibrium elastomeric properties of a polymer network. The final lecture on this day was presented by Prof. A.J. Staverman (Univ. of Leiden, The Netherlands). He reviewed molecular theories of rubberlike elasticity, contrasting real networks with idealized "phantom" networks (in which the chains are assumed to transect one another freely). Also discussed were refinements to the current theories, as well as some challenging unsolved problems.

Prof. W. Burchard (Univ. of Freiburg, FRG) gave the opening lecture on the following day. His experiments involved studies of highly branched polymers in the pre-gel state (where solution property measurements may still be carried out), and the use of such information to elucidate the corresponding, necessarily insoluble network structures. The systems chosen to illustrate this type of research were the biopolymers fibrin (involved

in blood clotting) and glycogen, and epoxy resins. The second lecture, presented by Dr. Y.Y. Gotlib (Institute of High Molecular Weight Compounds, Leningrad, USSR), focused on Brownian motions of network chains. The calculations described appear to be quite difficult, because of the variety of frictional effects and inter-segmental interactions which have to be taken into account. The concluding paper in this part of the program was on the mechanism of network formation by radical copolymerization, and was presented by Dr. G. Hild (Center of Research on Macromolecules, Strasbourg, France). The major conclusion reached in these studies was that such networks are much more homogeneous than had been thought to be the case. (A scheduled lecture by Dr. L.S. Priss [Scientific Research Institute of the Tyre Industry, Moscow, USSR] on the molecular origin of elasticity constants was withdrawn).

The last day of the meeting began with a lecture by Prof. H.L. Frisch (State Univ. of New York at Albany, US) on interpenetrating networks, i.e., composite networks in which the chains of one network interpenetrate the chains of the other. This is a very interesting type of network structure, particularly to those interested in problems of topology. However, their properties do not seem to be very different from those of the usual network stuctures, which are much less complex and much easier to prepare. The final lecture was presented by Dr. E. Oleinik (Institute of Chemical Physics, Moscow, USSR), who spoke on the properties of highly cross-linked epoxy-amine networks in the glassy state. Relatively little is known about such systems, in part because they are nonelastomeric and so highly cross-linked that there are only a limited number of techniques available for their characterization.

There were also two panel discussions and approximately 60 poster presentations, all dealing with some aspect of network preparation, characterization, or utilization in testing the various theories of rubberlike elasticity. Summaries of the lectures will appear in *Pure and Applied Chemistry*, and the papers presented in the poster sessions in the *Polymer Bulletin*. (J.E. Mark, Univ. of Cincinnati)

COMMUNICATIONS

COMMUNICATIONS R&D AT SWEDEN'S TECHNICAL HIGH SCHOOLS—PART II

Linköping Institute of Technology (LiTH)

The newest of Sweden's four institutes of technology is part of Linköping University, itself only 10 years old. Linköping (with *köp* pronounced like *chirp*) is located about 200 km southwest of Stockholm. Prof. Thomas Ericson, head of the Electrical Engineering Department at LiTH, commented that, when this new institute was organized, the decision was made to use the American universities' form of departmental organization rather than the British or classical Swedish form. So, instead of perpetuating the 1-professor-per-department tradition, his department's faculty includes 6 full professors. The "divisions" associated with the 6 professors are (freely translated Data Transmission, Information Theory, Computer Technology, Applied Electronics, Control Theory, and Computer Architecture. Most of my time at LiTH was spent discussing activities with the Data Transmission Group; some activities of the second, third, and fourth groups were also discussed

Ericson, himself, is the leader of the Data Transmission Group. At present, they are engaged in studies relating to source encoding techniques (for speech signals, primarily) and coding of digital communications for mobile radio systems. This latter effort on the part of LiTH is, in turn, a part of a long-term plan sponsored by the Swedish Telecommunication Administration to tie the far-flung, sparsely populated country more closely together by a set of interconnected, fixed, regional transceivers. Those transmitters/receivers would provide interfaces between the mobile and fixed components of a nationwide set of digital communication networks for use by the civilian common-carrier community and also by the government's military and paramilitary organizations. The short-term goal of LiTH's project is the specification and evaluation of an encoding scheme (including a forward-error-correcting code) and a suitable decoding technique to match the medium which is expected to exhibit strong multipath fading tendencies.

Their speech-coding efforts are directed toward telephone "toll-quality" applications. At the time of my visit, Mr. V. Ramamoorthy, a doctoral candidate in Ericson's group, was in the process of running a subjective comparison test between two systems, both of which encode speech at a 24 kbps rate. A 3 bit/sample conventional adaptive quantizer scheme (modeled after Jayant's work at Bell Labs) was being compared to an alternate scheme being

studied by Ramamoorthy. In this latter scheme, very coarse adaption is implemented by having two fixed signal quantizers included within the system. One of the two is designed to operate efficiently on the quasiperiodic, relatively high-level "voiced" segments of speech while the other is designed to be "optimum" for the low-level, noise-like "unvoiced" segments. The system operates by means of a voiced/unvoiced mode detector which provides a decision as to which of the quantizers ought to be operating on the signal during each 25 msec-long segment of the speech signal. (At present, both quantizers operate with the same output data rate, but this simplification would probably not be efficient in an operating system.) Preliminary results of this subjective comparison favor the Jayant adaptive quantizer system; a previous set of tests between Ramamoorthy's 2-mode system and a simple log-PCM quantizer with the same data rate favored the 2-mode system.

Ramamoorthy commented that the 2-mode model does not represent the true situation very realistically. Two inadequately-handled situations exist: first, as compared to the abrupt transition which this system employs, "soft" transitions often occur between the purely-voiced and purely-unvoiced conditions. The soft transition constitutes a mode for which neither quantizer is appropriate. Secondly, there are complex sounds (other than transitions) in some languages which include characteristics of both modes. Therefore, those sounds are not encoded optimally by either fixed quantizer. Despite its shortcomings, however, the 2-mode system is still of interest because it represents a forerunner to more general, multiple-subsource models for the speech signal. In turn, the enhanced model might aid in the development of a better objective distortion criterion than now exists, "better" in that it would match subjective evaluations more reliably and still be easy to evaluate.

An unrelated, recently completed activity, part of the mobile communication project, was an attempt to characterize the Linköping area (both downtown and suburbs) as a transmission medium in the UHF band, near 450 MHz.

Spatial and frequency-correlation analyses have recently been done using data which were obtained during a set of field tests that were carried out in 1978. In those tests, a mobile transmitter van was taken to 10 locations within the city and 10 in the suburbs. At each transmitting site, the antenna (a vertical dipole) was moved through a rectangular array of 70 positions, covering a 2λ-by-3λ area with linear resolution equal to $\lambda/3$. At each of those positions, the carrier frequency was stepped across a nominal 6MHz-wide band in 25 kHz steps. The receiver was located atop a 15-m-high building near the center of the city.

The analyses performed using that data have been somewhat disappointing. As might have been expected, in an environment where the number of significant off-line reflecting surfaces was small and where a line-of-sight path existed from many of the transmitter locations to the receiver, the Rayleigh distribution (which they considered) did not characterize the signal envelope very well at the low levels where the error-creating conditions exist. So far, their analysis effort has not included an attempt to describe the fading in more general statistical terms (as was done, for example, by Suzuki with other data in "A Statistical Model for Urban Radio Propagation," *IEEE Transactions on Communications*, July, 1977). Furthermore, both the space and frequency correlation analyses appear to be inconclusive. The $\lambda/3$ resolution in the data was only marginally capable of describing the local spatial variations which were of interest, namely in the region up to one wavelength, and the frequency correlation results exhibited such a large variance from position to position at the *same* location that no useful conclusion could be drawn.

A previously run set of tests did provide some useful error statistics for that channel. Those tests were run as part of a more direct approach: instead of attempting to *estimate* the types of error bursts which might result from the vagaries of the medium by studying the transfer function of the medium with probing by CW signals, they used a digitally modulated FSK signal (at a 12 kbps rate) and *calculated* the statistics associated with the errors which resulted. Lars Ahlin, one of the doctoral candidates involved in the study, conjectured that the next set of field tests will probably include a simple block-encoded cyclic parity-checking scheme for error control. To complement the algebraic coding approach they are considering the possibility of using the signal-level information available at the receiver to aid in determining the general location of a probable burst of errors within a long block of binary digits at the output of the demodulator-threshold circuit. Given that information, the set of redundant bits which were added at the transmitter can be used, in conjunction with presumably reliable bits within the block, to correct the errors that would have occurred during the time the signal had faded. As is the case for any forward error-correction coding scheme, this technique, called "erasure-burst" coding, can only be employed *efficiently* if the medium with which it is contending is well characterized and matched by the

code's parameters. The parameters of Ahlin's code have yet to be specified; he admitted, however, that the code can only be "matched" to the expected error bursts with great uncertainity. That condition exists because, in an urban traffic environment, the velocity of the mobile vehicle is highly variable and its velocity through the standing pattern of signal levels has a first-order effect on the duration of a signal fade. Feedback schemes have been ruled out for economic and spectrum conservation reasons, so the error-control coding must be done without the benefit of real-time data on the received signal level, or, for the case of transmissions to the mobile unit, the velocity.

Ericson ended our discussion with a description of some other work being done in the source coding area. Last year, they presented a paper at the International Conference on Acoustics, Speech, and Signal Processing in which a new source-encoding scheme, "Modulo-PCM," was described. It had been designed to work with correlated sources. This year, a modification to the original scheme was studied (and a paper describing this modification was presented at Lausanne). In concept, the original system transmits modulo-quantized data on signals whose maximum amplitude is many times greater than that which is unambiguously represented by the MD quantizer range, where D is the quantization step size and M is the number of steps. So, in effect, only the "fractional" part of the amplitude value is represented by the transmitted data. Reconstruction of the "integer" part might be accomplished at the receiver in a number of ways; they considered conventional linear prediction and also the use of a Viterbi decoding algorithm. In the new version, called "Modulo-PCM with Side Information," the system attempts to do better; it supplies the receiver with some "whitened" encoded data which is related to the "integer" part of the sample value. The side information is derived, within the encoder, by a feedback system which includes a decoder-like subsystem. The "local" decoder provides the encoder with an estimate of how the "remote" decoder will be interpreting the signal. Under most conditions of interest, this incremental "side" information, which the encoder derives and forwards to the receiver, reduces the probability of "integer" error in the receiver's decoded output. Their analysis of the system indicates that, for a Gauss-Markov source with correlation coefficient equal to 0.8, the operation at high rates is near optimum (that is, for a suitably chosen distortion criterion, it operates close to the corresponding rate-distortion bound), but it operates poorly at low rates. ("Rate", here, refers to the ratio of signalling rate to the Nyquist sampling rate.)

The Information Theory Division is led by Prof. Ingemar Ingemarsson. (He was absent most of that day, recovering from an American souvenir, a cold just carried back from a year's sabattical leave spent at IBM's research laboratory in Yorktown Heights, NY) The group's research activities deal with two general problems: encryption and image processing. With Ingemarsson's return to Linköping, the encryption system studies have been expanded to cover five aspects of the subject: (1) public key systems (including the generation and evaluation of cryptographic keys for special situations, e.g. a conference configuration); (2) security of data and programs within computer systems (as part of a general project dealing with office automation); (3) the development of a simple, yet effective algorithm for the encryption of pictures (taking into account the existence of an especially high degree of redundancy that exists in them); (4) the encryption of speech in the *analog* signal domain (to permit use of the standard voice-bandwith analog channels until the more desirable digital channels become more generally available); and (5), the development of encryption algorithms meant for implementation in software rather than in hardware. In addition to Ingemarsson, the group includes Drs. Viiveke Fåk and Rolf Blom and three doctoral candidates. Fåk's and Blom's recently published theses ("Data Security by Application of Crytographic Methods" [1978] and "Information Theoretic Analysis of Ciphers" [1979], respectively), together with Ingemarsson's own work in the cryptographic area provide the bases for extension into the impressive array of topics being studied.

Image processing, the other research activity being pursued within the Information Theory Division, is closely coordinated with two other divisions within the Electrical Engineering Department in an activity called the Picture Processing Laboratory (PPL). Ingemarsson's group emphasizes picture coding for storage and transmission and, as noted above, picture encryption.

Another group within PPL, from the Computer Technology Division, is headed by Prof. Per-Erik Danielsson and includes Asst. Prof. Björn Kruse. It has responsibility for the system design (and the algorithms and applications) associated with the overall processing system. A third group, headed by Assoc. Prof. Gösta Granlund of the Applied Electronics Division,

has responsibility for the implementation of the processor and the algorithms associated with it. Overall, PPL's activities constitute about 40% of the total research effort going on within the Electrical Engineering Department. Its complement of 35 people includes 7 researchers, 14 doctoral candidates, and 10 technical staff members. In the same area of interest, there is close cooperation between LiTH's PPL and the nearby Laboratory for Image Processing, a part of Sweden's National Defense Research Institute (FOA), also located in Linköping. (That laboratory has a staff of about 25 people).

The activities at PPL are very broad indeed. In the applications area, they are applying their PICAP system (a special-purpose PICture Array Processor) to the automatic detection of malaria parasites in thin blood smears, the coding of fingerprints, the automatic detection of labels in industrial environments, the inspection of printed circuit boards, the control of concrete's characteristics by the determination of the size, shape and surface roughness of particles within the mix, the measurement of mixture and contaminant ratios in seed mixtures, the classification of muscle fibers in muscle biopsies, the measurement of the distribution of the fibers' length in paper-pulp (as a quality-control measure), and the measurement of migration of white blood cells (despite the fact that the shape and size varies, splitting and collisions occur, and to make matters even worse, the data on living cells can only be derived by using phase-contrast microscopy, which provides very poor contrast).

In support of these and other applications, they are now redesigning PICAP; the second generation unit, PICAP II, will employ the new high-speed hardware devices which have become available since the existing PICAP was built about 6 years ago and will also be designed to allow multi-user, interactive capability. To support the interactive aspect of picture processing, a new high-level, Picture-Processing-oriented Language was recently developed. This language, called PPL (naturally), has already been implemented on the existing PICAP in a form which will facilitate its easy transfer to PICAP II.

In further support of the general picture processing efforts, new algorithms for high-speed operation were recently developed to "separate" objects and provide inter-object distances. A new analog-to-digital conversion method has also been devised to provide step response without "overshoot", a useful characteristic for interframe coding of "moving" pictures.

In general terms, they are studying models of the human visual system and quality measures (or distortion criteria) which complement their studies of picture coding for both moving and still pictures in either black and white or color.

Generally speaking, when I am exposed to such a heavy dose of *analysis* activity in a given area, I expect to hear about some synthesis also. I was not disappointed; in cooperation with FOA, they are doing picture synthesis work. The project is designed to provide full-color animation of dynamic surfaces and other graphical data to provide a simulation facility suitable for training fighter pilots. (Philip Fire)

ECONOMICS

INMOS: THE RISK OF GOVERNMENT RISK CAPITAL

During a recent House of Commons (UK) censure debate on unemployment, the Government announced its decision to fund Inmos' (a new venture company) second £25 million ($60,000,000) installment of a promised £50 million start-up grant. The additional funds will lead to employment opportunities for some 2,000 people in Cardiff or in the Newport area of South Wales when the new Inmos factory is in production in 1982. This announcement was politically advantageous to the Conservatives in a time of high unemployment and of restive rumblings from Wales. The project had been started, however, under the Labour Government to promote microelectronics production and use within the UK by providing the required risk capital.

The story in back of the political cream-skimming is possibly interesting and maybe even instructive.

The Labour Government announced backing of private-sector ventures in microelectronics in mid-1978. Three schemes were announced: two funded by the Department of Industry, Microelectronics Applications Project (MAP at £15 million) and the Microelectronics Support Programme (MISP at £70 million); and one under the National Enterprise Board (NEB), Inmos (two installments of £25 million each). The Inmos project was conceived as using public-sector funding and private-sector skills. The NEB expected to realize a good financial return from what was planned to become the first UK full-scale, mass-production semiconductor company, even though a good number of shares in the new company were reserved for future employees and for its founders: Iann Barron (UK), Richard Petritz (US), and Paul Schroeder (US).

Parenthetically, the French Government has been supporting three microelectronics ventures which are now about to go into production. Petritz and Schroeder had been involved in a company, called Mostek, in the US, and their skills in both management and technology were thought to give an excellent base for the Inmos venture. The company would set up in the US, and as progress was made, the design and production would be transferred in steps to some place in the UK.

The course for a successful venture seemed to be set, but when public funds are used as in this scheme, debate does seem to flourish. Criticism was leveled from the two extremes of political persuasions. One extreme complained that public funds were being used for private profit, while the other complained that the public funding would deter US private investment in semiconductors in the UK. Along with these generalized criticisms came the clamor from various parts of the country that new Inmos factories should be sited in their locales. The company had decided it wanted to set up in the Bristol area, but the Government remained undecided for some time whether to support the company decision. Such is the cost of Government-supplied capital.

In 1979 concerns of where to place a production facility may have appeared moot with the election of a Conservative Government. Indeed, without considerable support by industrial leaders Inmos, MAP, and MISP might have been abandoned.

Weighing the pros and cons of public opinion such as the UK Government has done is necessary within its societal constraints. Nevertheless, the timing of business thrusts, availability of markets, and prospects for competitive advantage have their own timetables not necessarily consistent with the time necessary for public debate and governmental decision-making. Inmos had developed a strategy based on the existence of technology windows which open shortly after the introduction of a new technological advance and afford an opportunity for new companies to introduce their products with competitive advantage. Such a window had opened for Mostek with a 4k bit dynamic RAM (random-access memory) and Petritz and Schroeder saw such a window for Inmos' new product, a 16k bit static RAM. The thinking probably was that a company which took advantage of the window would gain impetus which would carry it into the development of even newer products with adequate cash flow.

After all the debates and reviews it seems that Inmos will still be able to slip through the window. It plans to release its first product at the end of this year. Designated the IMS 1400, the chip will have a 16k × 1 format with 20-70 nsec access time and a 300 mW power consumption. The IMS 1400 will first be produced in the US with production transferred to a new factory in South Wales in 1982. Another factory, employing 1,500 people, will be built later in the UK. Products beyond IMS 1400 will include 64k bit memories (and perhaps larger ones), followed probably by a range of advanced integral-memory microprocessors.

Even though the decision on Inmos has been made, criticism continues. The Government is being criticized by some for its dilatory and niggardly support of Inmos in light of its much larger support of British Leyland and British Steel, both thought of by the critics as undeserving organizations. Some of these critics complain that higher technological goals could have been set for Inmos' first production chips. The Government has been criticized by others for its support of a silicon-chip technology which is already so cost-competitive that little profit from product can be anticipated. When these latter critics are asked whether Inmos might form a UK base for very-large-scale integrated-circuit technology and what future benefits might flow therefrom, they shrug their shoulders as many of us do. But with all the criticism, debate, and public review, the fact remains that Inmos has found over a tenth of a billion dollars in risk capital at a time when risk capital is hard to find. It will be of great interest to see how the Government attempts to protect its investment and how Inmos fares in production. (W.J. Condell)

ENGINEERING

MICROWAVE ANTENNAS AT L.M. ERICSSON IN GOTHENBURG

The L.M. Ericsson Telephone Company with headquarters in Stockholm is one of the world's largest telecommunication manufacturing organizations. It is Sweden's largest manufacturer of electronics for both commercial use and for defense. The defense electronics are concentrated in the division in Mölndal, a suburb of Gothenburg, and cover the whole range of equipment from low-frequencies through microwaves to infrared. The telephone company as a whole employs some 80,000 people and has net yearly sales of about $2.5 billion, 45% of which are related to the company's telephone business and 6% to defense requirements.

The Division in Mölndal employs some 2,000 people. It produces weapon systems from avionics to ground based mobile radars. The division is divided into finance and administration, marketing, engineering, and production. Engineering has 300-400 people and in its turn is subdivided into 5 groups of which the antenna group is one. Its manager is Olaf Dahlsjö, who has a staff of 32 people. Dahlsjö outlined for me the work of his group. Most of the projects were for Swedish defense applications, although there was also some involvement with the European Space Agency (ESA), and then there were some R&D efforts funded by the company itself.

The assistant manager, Dr. Lars Josefsson, described an investigation into the practical feasibility of a phased-array ECM (electronic countermeasure) jamming system in which electronic steering allows considerable antenna gain to be realized. Wide-band performance is required to select the enemy frequencies. A feasibility model was built at X-band with 16 adjacent H-plane wave guide horns stacked in the E-plane. They were connected to a transmitter and receiver with a microwave stripline corporate feed. The phase-shifters which were between the corporate feed and the radiating aperture formed by the horns, were built by Sedco Systems, Inc. (US) and were nonreciprocal, flux-driven, with an insertion loss of about 1 dB. In front of the radiating aperture was a 3-layer cylindrical wire grid circular polarizer supported by a dielectric structure. Typical performance figures at center frequency were: bandwidth 40%; elevation coverage 20°; azimuth beam-width 8.5°; scan angles ±60° azimuth; gain (broadside) 17 dB; polarization axial ratio < 6 dB; average power capability 100 W.

Another development, an X-band flat-plate antenna for missile seekers, was then described by Josefsson. The antenna gave monopulse outputs (sum and difference channels), had low side-lobes and was only 7 mm thick which gave it a good form factor for the application. The antenna diameter was 5.5 wavelengths. The aperture of the experimental model was formed by 52 stripline excited slots. The feed system was formed by multilayer striplines. The aperture was divided into groups of four elements, which (the four elements) were fed in parallel with equal power. The groups were cleverly combined with hybrids into three separate networks, one for each of the three antenna monopulse functions: sum pattern and split-beam difference patterns in elevation and azimuth. In this way the amplitude distribution across the aperture could be optimized by weighting the coupling coefficients to the groups separately for each of the 3 functions. This is very desirable since there is no common distribution that gives low side-lobe performance for both sum and difference patterns. Mechanical problems in this first model were encountered when the layers of the strip-line distribution networks were bonded, and it became evident that better assembly techniques were required.

Dr. A. Derneryd discussed a new X-band planar phased-array development with scanning in the vertical plane. The array was made up of 16 waveguides, each with 36 slots in the broad face. The waveguides were center fed with matched slots, giving a broadside beam, and the coupling was arranged for a -30 dB side-lobe Chebyshev distribution. Each array was measured individually in the presence of the other arrays which were resistively terminated, and the individual array 'element' radiation pattern was measured. This measurement showed the effects of mutual coupling and the extent to which the element was matched, including mutual coupling effects under all conditions of scan by showing what relative gain was contributed at any given scan-angle. All line arrays were investigated this way and a 'dummy' array was added at both ends but, still, the outermost active waveguide arrays had to be specially designed and matched. A total scan angle of 50° was achieved before grating lobes spoiled the performance. This could be seen from the element pattern where there was very low gain at the grating lobe angles. The program is ongoing and the whole system has not yet been assembled. Three-bit diode phase shifters for electronic scanning are being built and a solid-state transmitting-receiving module is being designed with 1-2 W power into each wave guide.

Derneryd also described some of his previous tasks which included such interesting things as covering resonant microwave structures with liquid crystals which then showed the field lines when microwave power was applied. He also worked with printed circuit patch-type radiators fed by striplines and achieved 13% bandwidth with a dielectric only 1/10 of a wavelength thick. This was a very good result. Better bandwidths can be obtained with feeds that connect from below the ground plate.

Ericsson participates in a multinational ESA L-Band program for 'satellite communications with mobiles.' Anders Molker described the system. It consists of a multibeam antenna array with the receiver and preamplifiers from Ericsson,

power amplifiers from Mullard, Ltd. (UK), beam-former from Marconi Space and Defence Systems, Ltd. (UK), temperature-compensated diplexers from Elektronikcentralen (Denmark), and Mechanical and Thermal Engineering from Contraves A.G. (Switzerland). The satellite-borne antenna gives a radiation pattern that conforms with a required footprint by using multiple high-gain beams. The antenna aperture itself is formed by an array with 18 elements of circularly polarized, short, backfire radiators and has a diameter of 2.1 m. Beam forming is performed at IF and is followed by upconverters and linear power amplifiers giving up to 9 W. An electrical demonstration model has been built to measure the 'active' radiation pattern, i.e., with all 19 beams being formed, each at a different frequency. This required a special test range with a remote receiver sending the data back. The test range was automated and computer controlled, and proper functioning of all parts was demonstrated. Phase II of the program, integration of the transmitter, still has reliability problems to overcome.

A whole set of Cassegrainian twist reflector antennas was seen, with diameters ranging from 37 to 67 cms. Lightweight sandwich construction was used. This type of antenna is very compact by virtue of the Cassegrainian subreflector principle with a parabolic main reflector, and it gives low side-lobe performance thanks to a polarization-twist technique which eliminates the aperture blocking effects of the subreflector. The use of carbon fibers in sandwichlike constructions for satellite-borne reflectors was being studied. Weight reduction by factors of 2 to 3 are believed possible. Experimental fibers are obtained from the UK.

The antenna range was visited and found most impressive with a rotatable platform that can be raised from the top of the roof by 11 m and can support a 2-ton antenna. The other end of the range is instrumented on a hill.

The spirit of the antenna team was wonderful and their enthusiasm was catching. They are undoubtedly a very competent group and prove it with their work. (T.C. Cheston)

TRONDHEIM'S ACOUSTICS REVISTED

Trondheim is a major center for underwater research and development in acoustics and offshore technology. This aspect was described in these notes about 3 years ago by Nunn and McKendrick (*ESN* 31-3:123 [1977]) and Pryce (*ESN* 31-9:380 [1977]). I visited Trondheim last summer and found that much new ground had been covered. This article emphasizes the acoustics aspects.

The city of Trondheim is close to the Artic Circle and is delightful in the summer (though one shudders at the thought of the long winter nights). It has about 130,000 inhabitants out of Norway's total population of only four million. The average population density is very low in Norway, about 30 people per square mile. The country achieved independence from Sweden only at the beginning of this century but a close relationship exists with Sweden as well as with all the other Scandinavian countries. Together with Denmark, Norway is an active member of NATO. English is spoken everywhere and there are strong ties with the UK and the US.

Trondheim is the seat of the only technical university in Norway: The Norwegian Institute of Technology (Norges Tekniske Høgskole or NTH). It started off as a school of mines (1811), changed its orientation towards engineering and architecture at the turn of the century and merged with other institutions to form the Technical University of Trondheim in 1968.

NTH has some 4,500 students and a staff of 1,500. It normally takes 4½ years to obtain the degree of Sivilingeniør equivalent to an engineering M.Sc degree, and 80% of the students make it in that time. There is considerable competition for entry and only about half of the applicants are accepted. Students get a small fellowship and can also arrange to receive loans. There are about 300 postgraduate students working for a PhD. It is planned to extend the facilities within the next three years and to increase the number of students to 6,200 undergraduates and 500 postgraduates. A second technical university is presently being planned.

The government has created a dense network of organizations that interact and integrate with NTH to such an extent that it is difficult for an outsider to distinguish between them. However, these organizations did succeed in a most noteworthy way in bringing the expertise from the university to bear on the technical problems of the government and industry. This interaction gives much relevance to the work of the university and makes that institution more aware of the rest of the world and its needs.

SINTEF, the Foundation for Scientific and Industrial Research (Selskapet for Industriell og Tekniske Forskning) is a private, nonprofit organization that was formed by the government to work with the university. In 1979 SINTEF's budget was

approximately $30 million. The Foundation is situated on the campus; NTH professors act as division leaders of SINTEF and SINTEF personnel take part in the NTH education program. It has a staff of about 850 people and carries out research and development shared about equally between industry, government institutions (e.g., the post office), and the Research Council. One of its divisions, ELAB (Electronics Research Laboratory of NTH, or Elektronikklaboratoriet ved NTH), employs 120 people. It is associated with the Electrical Engineering Department and shares that department's staff and laboratory facilities. No wonder it is difficult to keep them apart! To further complicate matters, another government-formed nonprofit organization on the campus, OTTER (Offshore Technology Testing and Research), is tasked to coordinate SINTEF with yet two other organizations: NSFI (The Ship Research Institute of Norway) and VHL (The River and Harbor Laboratory, which is also on the NTH campus). The staff of OTTER, however has withered away until it is almost non-existent and the other institutes liaise sucessfully on their own. The only further institutes mentioned in this article are the Royal Norwegian Council for Scientific and Industrial Research (NTNF), the Continental Shelf Institute (IKU), and lastly the Marine Research Institute of Bergen (FHI) which is part of the Fisheries Research Council.

The educational part of the university is run on very democratic lines, and all the employees have a considerable amount of say in how to conduct affairs. This is not true, however, of the SINTEF organization, where more autocratic businesslike procedures are in use.

Prof. A. Krokstad whom I visited, works in both NTH and ELAB and heads the Institute of Communications which includes acoustics. Dr. Jens M. Hovem is assistant professor under Krokstad and looks after the underwater acoustics part of the work. A total of 35 people in both education and research, including assistants, report to Krokstad. He is particularly interested in acoustics and the study of noise in buildings. Krokstad and his staff have several well-instrumented, standard reverberation rooms, 250 m^3 in size, with selectable temperature and humidity, which Krokstad uses to investigate ventilation noise and transmission losses through walls, doors and windows. His measurements are computer controlled. He has an anechoic room where noise from small gasoline engines (including motorbikes) is measured and he advises noise-control agencies on appropriate levels for legislation. Most interesting to me was his work on active noise cancelling—by transmitting antinoise, i.e., transmitting the same noise but in antiphase at the receiver. An active acoustic shield can be built in this way with an array of loudspeakers radiating in antiphase to cancel the impinging noise field, but cancellation is only in the direction of propagation and the energy is reflected, ideally into a matched load. A particular application investigated by Krokstad is the employment of active ear muffs which cancel high-intensity noise from gunfire by picking up signals just outside each ear. Balance has to be critically adjusted and is easiest at low frequencies.

A special listening room is being set up by Krokstad's group for loudspeaker systems and a van is being instrumented for general field work.

Hovem started the underwater acoustics work in 1972/3, and he is working closely with industry. He has a staff of 7 people. Early work in his group included parametric sonar-sources, propeller-cavitation noise reduction, and classification of fish by identification of their swim bladder.

A multibeam lens radiation system had been developed for a 450 KHz sonar with 104 elements, giving a 1/2° wide beam. All electronics were built inhouse. It is part of a special sonar system designed to inspect underwater pipelines and trenches

Present work includes a program to classify and size plankton. This is being attempted with a multifrequency or wide-band downward-looking sonar and spectral analysis of the returned pulses. It is hoped that species characteristics may stand out and that density may also be determined. Frequencies up to 2 MHz are available. Hovem and his people are about to begin making measurements with one-third octave wide bands. Funding is from the Marine Research Institute of Bergen (FHI).

Hovem's group participates with some of the organizations involved in Norway's offshore oil-related activities. Three of his people help in the development and planning of underwater navigation systems. A special project has just been started for investigating and classifying the sea bottom. This work is done in cooperation with the Norwegian Defence Research Establishment in Horten, near Oslo, and it is financed by the research council (about $17,000 for 1980). Its aims are to determine the physical properties of marine sediments from acoustic measurements; to develop sensors and signal processing for *in-situ* monostatic or bistatic measurements; and lastly to investigate appropriate propagation models. Even if it is only partially successful, the

program is likely to make valuable contributions to the fundamental understanding of sea-bottom characteristics and may make it possible to avoid the expensive and time-consuming drilling of cores, as is presently done, to obtain the necessary data for making acoustic propagation predictions or for routing pipelines.

Hovem kindly took me to the other side of town, to IKU (which, we remember, is the Continental Shelf Institute), and introduced me to Hans O. Torsen who heads the technology department. The emphasis at IKU is on improving the understanding of the shelf and its environment. Torsen and his staff gave me a summary of their projects in which about 90 people are employed.

J. Klepsivic and K. Klöv from IKU described a bottom-contour-mapping project which is being designed with a blue-green laser system that is expected to reach some 30-40 m. A Canadian system of this type is presently being tested off the Swedish shore. Bottom characterization is obtained with stereophotography. A. Tegdan described bottom-topography mapping by means of seismic technology that is being planned for late this year (1980) to identify acoustically the upper layers of the bottom. A 12-channel seismic towed array will be used for this purpose by GEOTEAM, a Norwegian geophysical exploration company. They will supply on-line printouts in real time and also make recordings on tape for later processing which will include a deconvolution using the recorded transmitted pulse. This project is sponsored by the Norwegian oil companies.

A topographical side-scanning sonar is being readied for sea tests in late 1980. The sonar is contained in a vehicle that is towed near the bottom at some 4-5 knots with an 1,100 m cable. Attitude is derived from a heading sensor (Digicore), and from depth and roll sensors. The sonar operates at 160 KHz, and has separate transmitter (1°) and receiver (1.5°) apertures arranged so that the transmitting radiation pattern has nulls that coincide with some of the receiver side-lobe peaks. It is expected to have an azimuth accuracy of 0.5° a range resolution of 1 m, and range of 200 m. The transducers are built by a Norwegian company in Bergen. The whole project was substantially a one-man effort started in August 1979—impressive.

Navigation is of course most important in mapmaking and IKU has an integrated system using satellite navigation, Loran C, Decca, Omega, the speed log, and gyrocompasses.

Oceanographic activities were discussed by B.A. Fossum. Special interest exists in ocean currents and these are measured both at the surface and submerged with an instrument developed by the Chr. Michelsens Institutt in Bergen. Surface-current data are used, for example, in computer-simulation studies of oil spills. A computer study of ocean currents has also been used successfully to plan a path by which a drilling platform was towed to its position. The data collection system includes drifting and moored buoys with Decca or satellite tracking. Buoys will be released from oil-drilling platforms to help predict oil-spill effects. A large buoy with recording capability has been developed by the Christian Michelsens Institutt. The firm is working now to develop buoys that contain microprocessors for data reduction, and will follow that effort with a communications via-satellite system.

M. Vollset took me to the dockside where the fully instrumented remotely controlled self-propelled submersible, the "Snurre" was located. This vehicle was developed several years ago but is being continuously modified. It was used successfully on many diverse missions including inspections of oil rigs and pipelines. At this time, pipeline erosion is being monitored.

The ocean has always been most important to Norway. Now, with oil, it is more important than ever. Norway is facing the many new problems that arise and is responding with a host of research and development efforts through specialized organizations. These are centered in Trondheim where the nucleus is formed by the Technical University. The creation and operation of so many interwoven organizations may be confusing to the outsider, but as they exist in Trondheim, they seem to be effective and worthy of note. (T.C. Cheston)

MARICULTURE

MARICULTURE RESEARCH IN ISRAEL

In Israel the white magic of the laboratory is everywhere. Science is in charge, with the scene dominated by experimental stations of every conceivable kind. During my recent visit, every marine scientist at the seven laboratories I visited was working on problems directly related to the Israeli economy.

One of the most energetic research centers that I visited was the Mariculture and Brackish Water Aquaculture Center for Research, Development, and Training,

in Israel's southernmost city, Elat, on the northern tip of the Gulf of Aquaba.

The center presently shares the physical facilities of the Steinitz Marine Biology Laboratory of the Hebrew University of Jerusalem (ONRL Report 23-68). The center is usually referred to as the IOLR Mariculture Laboratory and is a branch of the Israel (governmental) Oceanographic and Limnological Research Center (ILOR) in Haifa.

My host, the director of the center, Mr. Hillel Gordin, has completed all but his thesis for a Phd degree from Scripps Institution of Oceanography. He nodded his head and rubbed his eyes several times during the interview. Finally he explained his obvious weariness by telling me that he lived on a kibbutz (collective farm). The "dirty work" on a kibbutz is shared equally by all able-bodied members, even to taking turns washing dishes. Gordin's kibbutz milks its 250 dairy cattle 3 times each 24 hours to increase the production of milk by 15 percent. The night before we met, Gordin had been up until 4 a.m. taking his turn at the nighttime milking of the herd.

On the day prior to my visit, I arrived in Elat by bus after dark. The several kibbutzim (plural) in the valley just north of Elat shone like jewels in the clear desert air. Each kibbutz was lit up by a circle of bright "street lights" as part of its protection against raids from the nearby Jordan border. Several kibbutzim had dense clusters of very bright lights near their centers. Gordin explained that the lights were in greenhouses growing chrysanthemums on a 24-hour basis.

The mariculture center began in 1970 with the culture of two marine species: a native oyster (*Saccostrea Cuculata*), and a rabbit fish (*Siganus Rivulatus*). The culture of both species turned out to be intractable and was abandoned after two years of study.

It was decided near the end of 1972 to concentrate all of the center's talents and resources on all aspects of the culture of a single marine fish, the gilt head sea bream (*Sparus arata L.*). This species was selected because: (1) there was a good, established market for it in southern Europe where it sold for $2-5.00/kilo; (2) large numbers of fry with which to get started could be caught easily in Bardwali Lagoon on the north coast of the Sinai Peninsula; and (3) being a lagoonal species in its juvenile stages, the fish has a wide tolerance to environmental conditions. It is both eurythermal and euryhaline. It was rationalized that concentration on rearing one species would lead to profitable commercial farming in the shortest period of time.

After a few years of such concentration on culture of the bream, the research program was broadened and the 12 scientists at the center have specialized in the following mariculture subjects: (1) fish nutrition; (2) bacterial, parasitic, and metabolic fish diseases; (3) endocrinological and environmental approaches to controlled fish reproduction; (4) fish larval rearing; (5) sea-water and brackish-water fish-pond ecology; (6) marine fish-pond farming (monoculture and polyculture); (7) fish/oyster-pond polyculture system; (8) fish farming in floating sea cages; and (9) technological problems facing mariculture.

Tremendous advances were made in a relatively short time, and the center is now ready to set up a commercially sized pilot plant.

The most serious problems in bream culture are related to diet, with diet of the larvae heading the list. No larval-stage bream have been caught in the wild, so the researchers do not know what the natural food for the larvae is. Presently the green algae, chlorella, rich in proteins and B-complex vitamins, is cultured and fed to zooplankton rotifers which in turn are fed to juvenile larvae. This is expensive and time consuming and it is not known whether or not it is an ideal diet or whether or not it is deficient in some ways. The system is not sufficiently idiot-proof for commercial use.

The adult bream spawns up to several million eggs in a season with post-larval survival rate of a small fraction of 1 percent. Dr. A. Tandler has been able to increase the survival rate in the laboratory by several orders of magnitude to 2 to 5 percent. He believes that diet will be the key to increasing this rate of survival to an economically viable 15 to 20 percent. He would like to develop a fine-grained, coated-pellet diet containing all the essential nutrients. The coating would prevent leaching during storage. Because the bream is a carnivorous predator, the pellets have to stay suspended so that the larvae can "capture" them.

Dr. G.W. Kissel has been more successful in the development of weaning and post-larval diet. Mature fish can be grown twice as fast in an aquaculture center as they grow in nature. Most of Kissel's problems have to do with refining and reducing the cost of the presently used high-protein, high-vitamin diet. Relatively inexpensive fats are substituted for protein to furnish energy for the fish. Vitamins make up less than 1 percent of the diet but account for 30 percent of the cost of the diet, and their cost needs to be minimized.

Research is also underway on diets for other marine organisms that will be grown in polyculture with the bream.

A team of fish disease experts was established in 1973 and is headed by Dr. I. Paperna. It has been successful in essentially whipping many of the disease problems. Life cycles of parasitic vectors have been studied so that they may be attacked and destroyed when they are most vulnerable. Formerly many small bream were injured by the handling associated with moving them from small to larger and larger tanks as they increased in size. The problem has been solved simply by starting them out in a relatively large tank and leaving them there until they reach the post-larval stage.

The natural spawning season of the bream is only 3 months long. This season has been lengthened to 5 months by hormonal treatment but the exact mechanism is not understood. Ideally they are seeking means to have fish spawning all year round to keep the hatcheries and ponds busy and to have marketable fish all through the year. In nature some environmental change or changes trigger the spawning. Intensive research is now underway to duplicate the responsible mechanism or mechanisms at will and to understand better the hormonal triggering mechanism. It is believed that some combination of temperature, salinity, and photoperiod change is responsible for the natural triggering, but so far the answer has eluded the researchers.

Larval rearing remains the only major problem left unsolved and, as was mentioned above, improved diet is believed to be the key. Incubation techniques have been developed that hatch over 80 percent of good fertilized eggs. The 2 to 5 percent survival rate of larvae can at present only be achieved with a tremendous amount of labor and it is far from economical.

Farming techniques have been developed since the start of research on the bream. Floating sea cages were used in a protected bay 150 km south of Elat. Once past the larval stage the bream can be successfully and economically raised in these floating tanks. Fish grew to market size (250-300 g) in 16 months from hatching with a 1:2.5 food conversion rate at a density of 220 fish per m^3. However, protected bay areas are limited and the one in use will revert to Egypt shortly. Endeavors to raise fish in cages in open waters have had marginal success due mainly to occasional severe storms that wrecked the cages. Research is continuing in the hope of developing successful techniques for growing fish in open-water cages.

Research was begun on rearing bream in sea-water tanks. At first, yields were on the order of 1 ton per year per dunam (1000 m^2). However, yields have decreased every year due to primary production of phytoplankton of up to 80 tons a year per dunam. Most of this material drops to the bottom and rots, releasing toxic compounds such as H_2S, CH_4, NH_4, and others. Dr. Aryh Hughes-Games is culturing the Japanese oyster (*Crassostrea gigas*) in runoff water from the ponds. He reported that growth rate there was the fastest in the world. Some oysters have been sold in the shell for the half-shell market for $2.00/liter.

Elat is an area of very high evaporation which averages 3.5 m per year. Thus, new sea water must be almost continuously pumped into rearing tanks to keep the salinity at an acceptable level.

The newest program at the center is related to the culture of shrimp. Dr. Tzachi Samocha is in charge. He finished his doctoral research on shrimp rearing in the Department of Zoology at the University of Tel Aviv only 2 months before my visit. His research was on a Mediterranean species from a lagoon on the Sinai Peninsula. With this source closed to him, Samocha has turned to a shrimp from South Africa (*Penaeus monodom*). The tank I was shown contained postlarval shrimp 2 to 3 cm long that were feeding on the tiny brine shrimp, *Artemia*. The South African shrimp was selected because it has been successfully cultured in the tropics, grows very rapidly, and will tolerate a wide range of salinity. Research is underway on inducing spawning at any time of the year by using hormones and manipulating environmental conditions.

Gordin intends to increase his scientific staff in the future in order to pursue studies of the following subjects: (1) the genetics of fish, oysters, and shrimp; (2) economics of mariculture; and (3) mariculture engineering including pond design, pumping technology, the harnessing of solar energy, and biofermentation.

The success of the center's efforts with a rather crude physical plant where much of the culture is carried out under shed roofs open to the four winds and the most popular uniform is a scanty pair of swimming trunks, is attested to by the fact that the money-minded, hard-headed Israeli government is now ready to spend money on a new, multimillion-dollar set of facilities for the center. The new laboratory/pilot plant will be built near the Israeli-Jordanian border several hundred meters north of the tip of Aquaba on the outskirts of Elat. The center has been allotted 120 dunams (30 acres) of land for the first stage of development with an additional 150 dunams set aside

for future development. Unlimited brackish and/or sea water can easily be pumped to the new center.

The key to the new facility will be a controlled environmental hatchery laboratory and larval-rearing hall. All environmental factors will be controlled and monitored including light, air temperature, water temperature, and salinity. A large, shaded area will be built with tanks for spawners and advanced larval rearing. Induced spawning experiments will be carried out in a good biochemical and endocrinological laboratory.

The first stage will have sixteen 100-300 m^3 ponds near the hatchery. The ponds will be used to hold spawners out of season and to raise postlarval fish up to the size for pond stocking. A nutrition and food-chain-growing facility will be built along with a main laboratory and administration building. A training center for students and future fish farmers will be established to teach mariculture technology.

A semicommercial pilot-plant mariculture farm will also be built as part of the center with all the facilities that commercial farms will eventually have. This upscaling will enable scientists, engineers, and technicians to study problems which were not foreseen in small-scale R&D. It will also serve as a training facility. The aim is to have the first outside commercial fish farm on line by 1984.

Research on cage rearing in open water will continue and concentrate on the engineering aspects of protecting the cages from wave action. They plan to develop submerged cages and also floating breakwaters to dampen wave action, and to develop reliable anchoring and shock absorption systems.

Present estimates of the cost of constructing and outfitting the center during the first 5 years total $7,000,000.

Gordin has his own personal reasons for wishing to see fish farming become economically feasible in the Elat area. He explained that in order to be socially viable, a kibbutz needs to have a minimum of about 100 adults. His kibbutz has about that number but cannot grow any larger due to the limited rate of recharging of the ground water in the aquifer that the kibbutz uses for irrigation. He is looking toward mariculture as an alternate method of support for his and other kibbutzim in the area. To this end he is planning for a regional enterprise of 10,000 dunams (2,500 acres) that he hopes will be built between Elat and Yotvata, 40 km to the north of Elat.

I was extremely well impressed by the quality and quantity of the research that was going on at the mariculture center under rather crowded, somewhat primitive conditions. Gordin and his associates radiated a contagious, can-do optimism. For them, the question was not whether they could solve their multitude of problems, but rather, of how quickly they could do so. (Wayne V. Burt)

MEDICAL PHYSICS

BONE RESEARCH AT YORK UNIVERSITY

After WWII there was in effect an educational revolution in the UK. It was widely felt that Oxford, Cambridge, and the University of London could not by themselves supply all the educational needs of Great Britain. This sentiment led to the planning, funding, and construction of a considerable number of additional colleges and universities throughout the UK. One of these was the University of York at York, England, completed in the early 1960s. Recently I had the opportunity and pleasure of visiting there to see Prof. John D. Currey in the Department of Biology.

Prof. Currey's research interests include the study of the mechanical properties of bone tissues, particularly as they relate to biological function. He has demonstrated in a series of first-rate papers that bone tissues have very different characteristics, presumably as a result of evolutionary changes that optimize the ability of these tissues to perform certain tasks. The importance of knowing something about bones may be self-evident. About 20% or more of postmenopausal women are subject to osteoporosis, a condition characterized by a thinning and weakening of bone structures (*ESN* 34-5:233-235 [1980]). It is not even certain whether osteoporosis is a disease or an aspect of aging. The loss of calcium from bones in limbs that are inactivated for one reason or another is well known, extending even to astronauts on long, gravity-free space flights. Divers are subject to an ailment called osteonecrosis, associated with overly long careers as divers, especially at ages past thirty-five. There are many conditions that upset calcium metabolism and lead to a weakening of bone tissues. Suffice it to say that a good bit more needs to be known about bones. In one especially interesting study published in the *Journal of Biomechanics* recently (Vol 12, 313, 1979) Currey considered the mechanical properties of three different bone tissues: a deer's antler, a cow's

femur and a fin whale's tympanic bulla (part of the hearing organ). The purpose of the comparison was to note whether and how the properties might relate to needed functions, thus providing a rationale for the differences.

The antler specimens were obtained from a red deer (cut off, not shed). The cow's femur was from the slaughterhouse, from a mature animal that had been stored deep-frozen for 6 months. The tympanic bulla from a fin whale, was a specimen several years old. The testing program was designed to measure three mechanical properties: the work of fracture, which gives some idea of the impact strength; bending strength, which is a general measure of static strength; and the modulus of elasticity in bending, which is a measure of stiffness.

Tympanic Bulla (photo by J.E. Neighbours)

The work of fracture is a measure of the energy expended in driving a crack through a material. The specimens were thoroughly soaked in water, and machined and tested wet. (Author states that bone in general is remarkably unaffected by drying as long as it is made wet again before testing).

For the measurement of the work of fracture the specimen is prepared by having a deep notch cut into it. The notch will have a large stress concentration, and is the place where the crack will start. The specimen was loaded in bending. The other two tests (bending strength and modulus of elasticity) were also determined in bending, but on unnotched specimens. In addition to the mechanical strength tests, measurements were made of the bone densities and the percent ash content (mineral content).

Currey's measurements are summarized in Table 1.

TABLE 1

Measurement	Antler	Femur	Bulla
Work of fracture (J/m^2)	6186	1710	200
Bending strength (N/m^2)	179.4×10^6	246.7×10^6	33.0×10^6
Modulus of elasticity (N/m^2)	0.74×10^{10}	1.35×10^{10}	3.13×10^{1}
Mineral content	59.3%	66.7%	86.4%
Density (kg/m^3)	1.86×10^3	2.06×10^3	2.47×10^{3}
Speed of sound (m/s)	1990	2512	3542

The differences in both the work of fracture and the bending strength are quite large. Currey has shown in prior work that large differences in mechanical properties can be due to differences in mineral content (calcium hydroxyapatite). (The speed-of-sound listing is a computed quantity, determined as the square root of the ratio of modulus of elasticity to the density.)

The high mineralization value for the bulla is associated with the high value for the modulus of elasticity. While the mineralization difference between the antler and femur is relatively modest (59% vs 67%), Currey has shown in other work that the stiffness (i.e., modulus of elasticity) of bones is a sensitive function of the mineralization.

The very large work of fracture associated with the antler is associated with its ability to undergo plastic deformation. Indeed in the bending tests the antler specimens showed large amounts of plastic deformation. By contrast the bulla specimens were very brittle, and virtually no plastic deformation was observed.

The femur exhibits the highest bending strength, and has an intermediate value for mineralization. Other workers have also found increases in static bending strength with moderate increase in mineral content (Currey, J., *Biomech* 2, 1-11, 1969; Vose and Kubala, *Human Biol* 31, 262-270, 1959).

Currey then considers what adaptive values these mechanical properties confer on these very different animals. The antlers in red deer are found in the males only. They are used in fighting

and in display. If the males fight, then the antlers are loaded in impact. It is clearly important for the deer that the antlers should not fracture, and indeed it is advantageous for them to be able to absorb energy in plastic flow. Thus the high impact resistance of the antlers that goes with high work of fracture is an important property for the red deer.

On the other hand, the femur of the cow needs to function as a lever and a prop, and to be reasonably stiff. The femur in the cow is subjected to large loads and must be able to bear large stresses and be somewhat resistant to impact. The fact that the femur is covered by muscle and skin increases considerably the energy required to break it (Currey, J., *Acta Anat* 71, 87-93, 1968). Thus the high bending strength of the cow's femur provides the requisite static strength along with reasonable stiffness.

Currey makes an interesting case for the unique mechanical properties of the tympanic bulla. The function of this bony tissue differs considerably from that of the bones discussed above. It is to assist in making the hearing of sound by the whale an efficient process. In air much of the sound energy reaching the body of a mammal is reflected. The small portion absorbed by the ear accounts for the hearing. In water the body is much more transparent to sound. This fact causes a problem, since sound waves passing through the body and affecting parts similarly would make hearing difficult. Whales solve this problem by isolating the ear from the rest of the body. In the whale the tympanic bulla and the associated periotic bone (together called the petrotympanic) surround the inner ear, and are relatively isolated from the rest of the skull by having as their only support two slender peduncles. The bulla and periotic bone are also surrounded by a gasfilled foam. As a result the inner ear and its protective surrounding tympanic bulla remain relatively stationary under the influence of sound, while the rest of the whale vibrates around it. Further, if the ear is to act as a directional sense organ, the sound should reach the oval window (part of the internal ear structure) via movements of the tympanic ligament (homologue of the tympanic membrane of land mammals) only. Conduction through the bones of the petrotympanic should be as small as possible. The fraction of sound energy reflected from a common interface between two media (idealized as two semi-infinite regions, with assumed normal incidence) is given by: $\left(\frac{Z_1 - Z_2}{Z_1 + Z_2}\right)^2$ with Z_1, Z_2 the acoustic impedances of the two regions. Z can be computed as the product of the density and speed of sound for solids, or the square root of the product of density and modulus of elasticity. For water and tendons, the fraction reflected when the sound is incident on the tendon tissue is only about 1%. By contrast the fraction reflected when the sound is traveling in air and is incident on tendon tissue will be 99.9%. Accepting Currey's thesis that the tympanic bulla's function in the hearing process is optimized when minimum sound is conducted through it (or maximum sound is reflected), one may calculate the fraction reflected as a function of the properties of the tympanic bulla and of the adjacent tissues. Over a part of its periphery the bulla is supported by connective tissue. If it is assumed that the connective tissue behaves acoustically like tendon, then one may compare the fraction of sound reflected at a connective tissue-ordinary bone interface with a connective tissue-bulla interface. Table 2 lists the parameters needed to make the calculation.

TABLE 2

Tissue Type	Density (kg/m^3)	Speed of Sound (m/s)	Acoustic Impedance Z (kg/m^2s)	Fraction Reflected $[(Z_1-Z_2)/(Z_1+Z_2)]$	
Tendon (connective tissue)	1.1×10^3	1651	1.82×10^6	0.231	
Bone	2.06×10^3	2512	5.17×10^6		0.431
Bulla	2.47×10^3	3542	8.75×10^6		

As the numbers in Table 2 show, the reflection fraction at the connective tissue-bulla interface is 43%, considerably greater than the 23% associated with a connective tissue-ordinary bone interface. Most of the increase is associated with the greater value for the modulus of elasticity, which in turn arises from the greater value of mineral content. The "price" paid for the efficiency achieved in sound reception is a lack of strength (low work of fracture, low bending strength), coupled with a degree of brittleness. However the petrotympanic of the whale is isolated from the outside world, and even from the rest of the skull. Thus strength properties are relatively unimportant.

Currey's general thesis, that the differences in bone properties are associated with the adaptive requirements of the animals, is well supported.

Before concluding (and at the risk of comparing apples with oranges) it may be of some interest to compare Currey's data with values that my colleagues and I (Univ. of Calif., Los Angeles [UCLA] School of Medicine) obtained for human cortical bone, *in vivo*, by totally different methods. We have studied the elastic properties of the human femur and human radius non-invasively, *in vivo*, using an ultrasound technique. One index of bone properties is the speed of sound. For a group of normals consisting of 9 females and 18 males we measured the speed of ultrasound in femoral and radius cortical tissue (Andre et al, *Med Phys* 7(4), 324, 1980). We also computed values for the modulus of elasticity and the percent mineral content based on measurements of the radius in a somewhat different population of normals (Greenfield, M.A., Craven, J.D.: V International Conference on Medical Physics, Jerusalem,August 1979). Table 3 lists the values we obtained along with Currey's for comparison.

TABLE 3

Measurement	Antler	Femur	Bulla	UCLA Human Femur
Modulus of elasticity (N/m^2)	0.74×10^{10}	1.35×10^{10}	3.13×10^{10}	2×10^{10}
Mineral content	0.593	0.667	0.864	0.63
Density (kg/m^3)	1.86×10^3	2.06×10^3	2.47×10^3	1.8×10^3
Speed of sound (m/s)	1990	2512	3542	3230

On Currey's scale the measurements of the human femur, *in vivo*, at UCLA would land, somewhat roughly, between the bovine femur and the whale bulla, at least for the speed of sound and the modulus of elasticity. The other two (mineral content and density) are comparable to the bovine femur values, or a bit less. It may also be noted that in the human the comparable bone tissue to the petrotympanic is the bony labyrinth which consists of harder, denser bone than the surrounding parts of the temporal bone. In a radiograph of the skull the bony labyrinth appears with a greater density than adjacent bones. (Moses A. Greenfield)

THE CHANGING PATTERN IN THE FREQUENCY OF RADIOLOGICAL EXAMINATIONS IN GREAT BRITA A COMPARISON BETWEEN 1957 AND 1977 SURVE

This past September (1980) was the occasion for the annual conference of th UK Hospital Physicists' Association, whi was held at Leeds University. There are now over 1,300 members of this lively or ganization which is dedicated to effecti improvements in the delivery of health c to patients. As physicists, they are trained to advise in the most efficaciou ways to use x-rays in obtaining needed diagnostic information. Among the sever score reports, papers, and posters prese ted at the meeting the following three reports on the radiation exposure from diagnostic radiology to the population of Great Britain in 1977 were of special interest: (1)NRPB-R 104, "A Frequency Survey of Radiological Examinations Carr Out in National Health Service Hospitals in Great Britain in 1977 for Diagnostic Purposes," by G.M. Kendall, S.C Darby, S.V. Harries, and S. Rae, June 1980; (2) NRPB-R105, "Current Levels of Gonadal Irradiation from a Selection of Routine Diagnostic X-ray Examinations in Great Britain," by B.F. Wall, E.S. Fisher, P.C Shrimpton, and S. Rae, July 1980; (3) NR R106, "The Genetically Significant Dose from Diagnostic Radiology in Great Brita in 1977," by Darby, Kendall, Rae, and Wa All three are published by the National Radiological Protection Board at Harwell Didcot, Oxon OX11 ORQ.

As indicated above, the reports are the work of staff members at the Nationa Radiological Protection Board. This gov ernmental agency was established by The Radiological Protection Act of 1970, and is charged with "carrying out research a development and providing information advice and services to those responsible for radiological protection." This repo is a discussion of the first of these th publications. Although the survey data which the reports are based were obtaine in 1977, the data analysis and report preparation required some three addition years.

Medical irradiation is by far the largest man-made source of the radiation dose received by the population of Great Britain. Precisely the same statement c be made for any country with modern capa bility for delivering health care. It i helpful, however, to put this radiation exposure into some context by comparison with other sources of radiation to which people are exposed. For example, the an nual, genetically significant dose to th UK population is made up of the followin components:

TABLE 1

Natural Background	89.4%
Medical Irradiation	9.0%
Fallout	0.6%
Miscellaneous	0.4%
Occupational Exposure	0.4%
Disposal of Radioactive Waste	0.2%
	100.0%

Contributors to Gonadal Dose

On this basis, medical irradiation accounts for only 1/11 of the total. It is a somewhat larger fraction (30%) of the total somatic dose in Great Britain. However, it is appropriate to recall that irradiation for medical purposes differs from other kinds of exposures in terms of the benefit derived by the person receiving the dose. Although this benefit normally outweighs any hazard, it is still necessary to keep exposure doses as low as practicable compatible with obtaining good diagnostic information. The last national survey was done in 1957 by a committee chaired by Lord Adrian ("Radiological Hazards to Patients: Second report of the Committee under Lord Adrian," London, Her Majesty's Stationery Office [HMSO],[1960]).

The survey discussed here was restricted to the hospitals associated with the National Health Service (NHS) in Great Britain. However, the extent of radiological practice outside of the NHS was estimated, and the results were included with those of the NHS. One of the purposes of the survey was to estimate the Genetically Significant Dose [GSD] in Great Britain. This task required not only measuring the exposures associated with radiological practice but also obtaining child expectancy data, since the latter figure in the computation of GSD. One defines GSD as that dose which, if given to every member of a population, would have the same genetic consequences as the actual distribution of doses.

An appropriate sampling of hospitals in England, Scotland, and Wales was made to ensure that the estimated total number of radiological examinations would have a standard error of about 2%.

There are some 1,149 hospitals in England with radiology departments. In Wales, the number of such hospitals is 131, and in Scotland, 151. The sample sizes chosen were 79 hospitals in England, 5 in Wales and 28 in Scotland. Useful data were ultimately obtained from 54 hospitals in England, 5 in Wales (all responded) and 22 in Scotland. Thus, the overall response rate was 68%, which was thought by the authors to be somewhat low. However, a considerable amount of work was entailed by the cooperating hospitals, and the resources participating in the study may not have been available to the others.

The first part of the survey was designed to learn the frequency with which selected radiological examinations were performed. For this purpose some 48 examinations were defined including abdominal, chest, head, extremities, barium enema, computerized tomography (CT), spine, mammography, intravenous, and pyelography, to mention but a few of the more familiar kinds.

What were some of the findings? The total number of diagnostic radiological examinations performed in NHS hospitals in Great Britain in 1977 was estimated to be 21.3 million. This was equivalent to 393 examinations per thousand of population (based on a population of 54.2 million), and represented an increase of 61% over the estimate of 13.3 million for the national survey made in 1957. However, the increase in number of examinations per thousand was somewhat less, about 48%, since the population of Great Britain had increased in the 20-year interval (from 50 million). The per-annum rate of increase in number of examinations per thousand was approximately 2%, which was in good agreement with similar estimates for comparable countries. A more complete view is obtained when account is taken of radiological examinations performed outside the NHS hospitals. When these are included, the number of examinations becomes 23.8 million, with 440 examinations per thousand. This is somewhat less than has been reported in some other countries. See Table 2.

TABLE 2

Country	Survey Year	Examinations per Thousand
West Germany	1974	1660
Japan	1974	810
Sweden	1974-76	650
USA	1970	670
Great Britain (this survey)	1977	440

Frequency of radiological examinations per thousand of population in some countries

The numbers of examinations per thousand were effectively the same for males and females. One-third of all examinations were of the chest, heart, and lungs. No evidence was found of an increase in absolute number of chest examinations, and these formed a smaller proportion of all radiological examinations than in 1957. However some other types of examinations (femur, ankle, foot, arm, head, cervical spine, pelvis,

lumbar spine, abdomen) had increased in frequency by factors of two to three. Perhaps the largest increase was in examinations of the pelvis, with increases by factors of five for women and four for men.

About 6% of all radiological examinations involved fluoroscopy. There has been a sharp fall in the frequency of fluoroscopic examinations of the chest.

The mean number of films per examination was estimated to be 2.4. This represents some increase over the 1.9 reported in 1957 by the Adrian Committee, and probably reflects the increased complexity of modern radiology.

Studies of the variations in frequency of radiological examinations by age show a general increase with age (the 60 years and older group has about twice the frequency rate of the 0 to 15 age group). Compared to the 1957 survey, the increase in examination rate was most marked for the very young(0-4 years) and the older group (60 and above), especially for females. Examinations of the chest, heart, and lungs were relatively rare for children but common among older persons, especially men. However examinations of the arm below the elbow were most common for early teenagers, falling off sharply for females after the age of 15.

With reference to Table 2 Great Britain has the smallest estimated number of examinations per thousand in comparison with some other countries. There is some opinion that these numbers may relate to national prosperity (United Nations Scientific Committee on the Effects of Atomic Radiation; New York, UN, 1977.) The fall in frequency of chest fluoroscopy is thought tobe associated with the lessening incidence of pulmonary tuberculosis. There has been a dramatic reduction in the frequency of obstetric radiography from 114 per thousand live births in 1957 to 42 in 1977. This drop probably reflects the increased awareness of the radiosensitivity of the foetus, and the current availability of ultrasound for diagnostic purposes. Similiarly, with the availability of CT in recent years, there has been a significant drop in cerebral angiograms.

This *ESN* report on the frequency of radiological examinations in Great Britain will be followed by one on the level of gonadal irradiation as a consequence of routine x-ray examinations and an estimation of the associated genetically significant dose. (Moses A. Greenfield)

OCEANOGRAPHY

MARINE BIOLOGY IN THE HEBREW UNIVERSITY OF JERUSALEM

The Hebrew University is the oldest university in Israel, having been established in 1925. The use of its original campus on Mount Scopus east of the old city was lost to the Israelis for two decades, from the war of independence until 1967, during which time it was an enclave in Jordan. It was in this perioc that a second campus was built on the western outskirts of Jerusalem. A third campus was later built, still farther west, to house the medical school and son related departments.

Apparently the university's three campuses are filled to overflowing; I fou the Zoology Department located in an old government building right in the noisy center of Jerusalem. There I met Prof. F.D. Por, curator of the large aquatic invertebrate collection in the university zoological museum. In 1967 (ONRL Report 23-68), Por's primary interest was in the systematics and morphology of fresh-water copepods (small crustaceans that are normally planktonic), and he has publishe a monograph on the fresh water copepods of Israel. He had also done some researc on marine and fresh-water zoobenthos (bottom-dwelling animals). He has specialized on *Harpacticorda* (a microcrustacean copepod that usually lives on or in bottom sediments) from the Gulf of Aqaba the Mediterranean coast of Israel, and samples from the International Indian Ocean Expedition.

When Israel took the Sinai Penninsu from Egypt in 1967, hundreds of kilometer of coastline, essentially virgin from the standpoint of marine biology, were m available for study. Por's publications since 1967 indicate that he blossomed ou into new fields of research; he wrote on a wide variety of subjects concerning th Sinai Penninsula, the Suez Canal, and surrounding waters. In those regions there were vast hypersaline lagoons, extensive salt water mangrove swamps, and even more extensive coral reefs. The latter two types of areas contain symbio diverse populations of marine organisms.

Some of the subjects of Por's research were: (1) the limnology of a hypersaline heliothermal solar lake south of Elat that was mentioned in the Old Testament (I Kings 9); (2) research on the *harpacticorda* in the waters surround the Sinai, including migration northward of Red Sea species through the Suez

Canal into the Mediterranean Sea; (3) the hydrobiology of Bitter Lakes in the Suez Canal and hypersaline lagoons on the Sinai coast including the huge Bardowil Lagoon on the north coast; (4) the extent of "Lessepian" migration (after Ferdinand de Lesseps) through the Suez Canal (he published a book on the subject after identifying 600 species that had moved northward from the Red Sea into the Mediterranean Sea while only two species of fish had migrated in the reverse direction); (5) a survey of the biota of the Red Sea; and (6) the biota of mangrove swamps in the Sinai. Por and a collaborator, Dr. I. Dor, are now editing an encyclopedic volume on the mangrove swamps of the world.

Several other members of the Zoology Department are carrying out marine-oriented research. Dr. D. Kahan is working on the culturing of food organisms for the first stages of fish fry. Dr. C.H. Dimentman is working on improved methods of culturing the brine shrimp *Artemia* for fish food. Prof. A. Ben-Tuvia is an ichthyologist who has conducted research on the fish in the Sinai Bardowil Lagoon for years but now is out of a job due to the return of the Sinai to Egypt. He has catalogued the fish in the eastern Mediterranean, the Red Sea, and inland waters of Israel. Profs. M. Abraham and B. Eckstein are specialists in fish endocrinology and are working on inducing spawning of fish used in mariculture. Dor is a specialist on marine algae and the biology of mangrove swamps. Prof. Y. Parnas is a neurobiologist working on lobster culture at the Steinitz Marine Biological Laboratory in Elat. He will be in charge of the oceanography teaching program at the Hebrew University for the next two years.

Oceanography is concentrated in a program leading to the MSc. Students take coursework the first year and do a research project during the second year. An average of 5 new students enroll in the program each year; to date 45 degrees have been given. The emphasis is on either biological oceanography or geological oceanography. Visiting teachers are brought in for a term at a time to help with the teaching program. They usually come from the Oceanography and Limnology Research Center in Haifa. Sometimes they attract Jews from abroad such as Prof. Peter Weyl, from the State University of New York at Stony Brook, who spent 2 years at the Hebrew University. In recent years there has been a tendency toward moving part of the oceanographic teaching program to the Steinitz Marine Biology Laboratory in Elat. Por believes Israel should adopt the system used by the Marine Biological Laboratory in Woods Hole, Massachusetts, and concentrate the course work in Elat during the 3 summer months. He is pushing for a joint oceanography training program in which all of Israel's universities would cooperate. The course taught at Elat would be listed in all of the catalogues and students would obtain credit from their own universities. An interinstitutional committee has been set up to select and suggest about 15 courses as core courses in oceanography.

While I was talking to Por I found out that there was an extensive marine geological program in the Department of Geology, but unfortunately my itinerary was fixed and I did not have the opportunity to visit the department. I was told that the program was headed by Prof. Z. Reiss, a micropaleontologist, and that much of the recent research was based on grab and bottom-core samples from the Gulf of Aqaba. (Wayne V. Burt)

MARINE SCIENCE IN GENOA

The Oceanography Research Group, Gen (Gruppo Ricerca Oceanologica, Genova, wit its appropriate nautical acronym, GROG) is a part of the Institute of Hydrobiology and Fish Culture of the University of Genoa. It was jointly established in 1972 by the university and the Hydrographic Institute of the Italian Navy for the purpose of studying the Mediterranean Sea and the oceans on an interdisciplinar basis. The institute is housed in a 15th century palace in the older part of the city. It was originally a Jesuit theolog center. The palace's dingy exterior be belies its beautiful interior which has cloistered gardens, courtyards with fountains, and a great hall with frescoed walls and ceilings reminiscent of the Sistine Chapel in the Vatican.

A recent list of the staff indicates that there are 15 biologists, 12 chemists 5 geologists and geophysicists, and 3 physical oceanographers. Prof. N. Della Croce, a zoologist with interests in marine biology, is chairman of the group and was a prime mover in establishing the marine science program.

In contrast to the industry-supporte marine laboratory in Trieste (*ESN* 34-11:5 [1980]) the group in Genoa is supported solely by the Italian government through block grants from the Italian Research Council. The group occasionally uses the two former US research vessels *BANNOCK* (63 m former fleet tug) and *L.F. MARSILI* (55 m sister ship to the *PUEBLO*) that are operated by the National Research Council.

Genoa is the largest coastal industrial city in Italy. The establishment of the Oceanographic Research Group coincided with the recently enhanced interest in the effects of industrial and human pollution in the world's oceans. For this reason a good share of the research carried out by the group concerns marine pollution.

Some of the chemists work on nutrients and primary productivity, but the bulk of them are interested in distribution of heavy metals (Cu, Co, Cr, Mn, Ni, Cd, Zn, and Hg) in sea water, marine organisms, and sediments in the Ligurian Sea between Genoa and the island of Corsica. I interviewed the senior chemical oceanographer, Prof. A. Felletti, who is also dean of the faculty, and two of the leading analytical chemists, Ms. Dr. F. Baffi and Dr. R. Canelli. I was very much impressed with Dr. Baffi. She explained to me (in perfect English) some of her methods that had to do with working with low concentrations of metals and small samples in the presence of all the dissolved and suspended materials found in sea water. Baffi also explained that she did the chemistry work for fun and in her spare time, and that she was really getting paid for carrying a very heavy teaching load.

The chemistry group is testing marine organisms for PCB's and chlorinated pesticides and is studying the effects of heavy metals, pesticides, and petroleum hydrocarbons on marine organisms.

I also interviewed the senior physical oceanographer, Prof.I. Dagnino, whose primary interests are hydrodynamics and tides. He also does systematic hydrographic surveys of the Ligurian Sea and employs drogues to measure coastal currents that distribute local industrial pollutants.

There is an oil terminal 8 km offshore from the Genoa Harbor. Dagnino has instrumented the terminal platform for measuring water levels and wave heights and for recording micro-seisms. All data are transmitted to the shore laboratory by radio. Dagnino is also interested in waves caused by the weather with periods of the order of 20 minutes. These are common events and have heights of 7-8 cm, or a little less than half the height of the mean astronomical tides.

Although I visited the group on 1 July, the weather had been so cold that the seasonal thermocline and near-surface mixer layer had not formed yet. Della Croce postulated that the normal April-May spring phytoplankton bloom probably would be delayed until August, and that this would result in a very poor yield of primary production.

Another physical oceanographer, Dr. L. Papa, models the circulation, including meteorological input, in the Ligurian Sea. He is also interested in marine optics. The third physical oceanographer, Dr. C. Polau, works on projects with Dagnino. His main interest is in the energy budgets in coastal waters.

Della Croce was very much worried about future funding for marine research. He explained that Italy had no national oceanographic program and that no one in high places lobbied for marine science. He stated that all the governmental advisory panels for science were dominated by scientists from older, well-established disciplines and that when the pinch was on, as it is now, the newer, smaller sciences were apt to be cut before the older ones were affected. (Wayne V. Burt)

OPERATIONS RESEARCH

OPERATIONS RESEARCH IN IRELAND

"OR in Ireland is different from OR in England," was the first thing that Randal Faulkner, the president of ORSI (Operations Research Society of Ireland) told me. Ireland is a small country and most of the firms are small, many of them having only one or two people doing operations research. The entire OR society has only about 150 members; at a typical annual meeting 30 to 50 members attend for a period of 1½ days and a dozen papers are presented. (By contrast, there were 22 simultaneous sessions, and more than 1,000 papers were presented, at the meeting of the Operations Research Society of America in Colorado Springs in November 1980.) In many cases these small OR groups do other things than OR, and so it is hard to tell where OR stops and other things begin. Nonetheless, Faulkner asserted that a lot of good OR is being done in Ireland, even though some of it may be done under different names, of which, perhaps, the most common today is "Management Information Systems."

It is of interest to note that the Irish use the American phrase "Operations Research" rather than the British phrase "Operational Research." This may be because this form of the phrase is shorter and easier, or it may reflect something about the feelings of the Irish. In Ireland, perhaps more than in other countries, one is often reminded (even in connection with something as supposedly objective as OR) of the history of the country and the chauvinism of its people. The immediate past president of ORSI, Cathal Lennon,

suggested during his presidency that the meetings of ORSI should be held in Gaelic (the Irish language), and there was some discussion of splitting into two societies.

Faulkner himself constituted one of these one-man groups at the Guinness Brewery until recently, when he was promoted to become head of distribution. At the present time no one nominally does OR for this corporation, although a search is supposedly being made for someone to take up Faulkner's OR work. In spite of the small size of the OR effort, Faulkner appears to have been able to accomplish a great deal, much of it in conventional studies which were nevertheless very useful to the company; for example, he set up vehicle scheduling, he did a study on optimum vat size which resulted in a change in the size of vats which Guinness was building, and he built a computer simulation of the keg line. He has also prepared a proposal to obtain a grant in excess of a hundred thousand pounds from the EEC for software development at Guinness, and it appears that this will be funded. This is all the more extraordinary when one learns that Ireland's total contribution to the EEC is only about a hundred thousand pounds a year.

Most of the prominent OR community in Ireland is associated with government and industry rather than with academia, in startling contrast to the situation in the US and UK. An exception is Enda Hession, a member of the ORSI council, who has just been named dean of the Faculty of Commerce at University College Dublin (UCD), of which more below.

Cathal Lennon trained as a nuclear physicist, became interested in computers, and from there went on to systems analysis and operations research. He spent 4 years doing economic planning and OR with airlines, and then joined a large accountancy firm called Stokes, Kennedy, Crowley. He is now a partner in this firm and heads the consulting group of some 50 people, of whom about 3 are primarily OR people. Their most important work to date has been done in the health-care field. An interesting project which they recently completed involved forecasting the patient load in an acute-care hospital, because of the hospital's frequent inability to handle the demand. What came out of the study, rather unexpectedly, was the discovery that more than 20 percent of the patients could have been handled perfectly well in other, less expensive institutions. This resulted in a recommendation for changing the diagnostic procedures and the screening procedures for admission, and it is anticipated that many of these patients will, indeed, be directed elsewhere. Lennon's group also had a major contract from the Fisheries Development Board, a semi-state body, to complete a plan for fisheries development. The group built a massive computer simulation of the catching, landing, and processing of the fish, and then manipulated this model in an attempt to optimize the contribution to gross national product. With the exception of the criterion function, much of this was similar to work reported in *ESN* 34-10:487-489 (1980).

Another past president of ORSI is Des Byrne, who did postgraduate work in operations research at Case Western Reserve University, Cleveland, Ohio. Byrne has now also moved up out of OR into administrative work and is presently personnel director for Guinness.

Still another past president of ORSI is Brian Lenihan, who took his MS in OR at Ohio State University and is presently running a large (for Ireland) OR department of 8 people for the Public Service, which is equivalent to the Civil Service in our country. Much of their work is for the Guard (which means police) and for agriculture. For example, they have done an analysis of driver's license tests. Apparently until recently, because of a peculiarity in the law, many people were permitted to drive without ever having passed such a test, but since this is no longer being permitted, the tests have taken on considerable importance. A large fraction of those taking the test fail it and must be retested. A previous study of this data had apparently been quite naive and had drawn some incorrect conclusions. For example, it assumed that those who were retested represented a simple random sample of those who had failed the previous test, whereas the sample was actually highly biased because it did not include those who failed to return to be retested (those who dropped out of the system), and who apparently had quite different properties.

They had also done some analysis of ambulance service, and this analysis involved building up a significant simulation. The question that had been put to them was: how many extra ambulances were needed to improve ambulance service to the point at which 95% of all people callir for an ambulance would actually be picked up within 25 minutes? As it turned out, the answer was "none"; the improvement was achieved instead by changing the locations of the ambulances which were on call. In the past they had all been at the hospital, and they were moved to various other strategic locations. There was also considerable discussion of the possibility of introducing special coronary

ambulances for heart-attack patients. Lenihan's group did a study which showed that the number of lives that could be saved by such a special ambulance would be well under one per year, and since the cost would have been extremely high, the project was dropped.

Another OR study conducted by this group was concerned with tuberculosis in cattle. There are some 7 million cattle in Ireland and, by EEC regulations, the incidence of TB must be below 0.5% per herd and below 0.3% of the total number of animals (the distinction arises because if there is a single infected animal the entire herd is assumed for this purpose to be infected). An ingenious and extremely simple study showed an excellent goodness of fit of the distribution of TB to the binomial probability distribution, which is what would be expected if the incidence of this disease were independent of the presence of the disease in other animals. In other words, the statistics showed no evidence of contagion. A second study was a Bayesian analysis of the probability that a herd would become diseased given its past record of disease incidence. This analysis, which showed that herds which had never been infected were likely to stay uninfected, resulted in a most effective recommendation to concentrate preventive efforts on herds which had a history of disease even though they had been officially declared absolutely cleared of infection.

Lenihan's OR group worked for many different departments of the Irish Government, and I was surprised to discover that no charges were made for these services. Apparently if anybody wanted an OR study done, informal suggestions to that effect were made and the study was performed. I would have guessed that in such circumstances, the implementation rate might not be high, since people might value such studies less if they did not have to pay for them, but Lenihan assured me that his implementation record was excellent.

Still another past president of ORSI is Fred Ridgway, head of OR for the Bank of Ireland. In spite of the official implication of the name (which arose because in the distant past the institution did finance the government of Ireland), the Bank of Ireland is just a commercial bank. The official bank of the country, which corresponds to the US Federal Reserve, is called the Central Bank of Ireland. There is also, in the Irish banking scene, an "Irish Banks Standing Committee" which constitutes a cartel. If the Bank of Ireland, for example, decides to raise the charges it makes for checking accounts, it works through this cartel, and all banks increase their charges simultaneously. Since the Bank of Ireland is the only one with a significant OR group (Ridgway has 4 other analysts plus supporting personnel), this group performs many of the studies which lead to actions taken by the other banks as well as by the Bank of Ireland.

Ridgway graduated as a physicist from the University College Dublin some 20 years ago and, he told me, "learned OR by osmosis." After working as a physicist in England, he became manager of research and development for an American firm in Ireland and began to apply OR techniques in building schedules for that firm. Subsequently, he became the OR man at a semi-state body, CIE, the transportation organization in Ireland. He was brought in to head the OR group at the Bank of Ireland when the group was set up in 1967 as a result of a major reorganization of the bank (which followed on a management study by an American firm, McKinsey & Company). Interestingly enough, there were severe difficulties in hiring him at that time, because the contract between the Bank of Ireland and its union specified that no one over 21 years of age could be hired by the bank. The idea was that the top jobs, such as manager, should go to members of the union who have worked their way up through the ranks. However, there was clearly no one within the organization who could take on the job as head of OR, and so a special dispensation was given to allow Ridgway to be hired. While he was on sufferance for some time, he now appears to have a "permanent job."

Although the bank has never laid off a single worker, its union appears to be unusually militant, and there was recently a strike which lasted 6 months. Possibly because of this militance, Ridgway's group has always stayed away from tactical issues and has concentrated on strategic ones. For example, the most important study done by the group was an analysis of the lending structure of the Bank. The Bank of Ireland and other Irish banks had been doing the bulk of their lending through what was called "overdraft lending," which was essentially equivalent to giving the customer a line of credit and allowing him to borrow at his convenience any amount up to the agreed maximum, repaying as much as he liked when he liked, and paying interest only on the amount held at any given time. Ridgway's studies showed that this was inefficient for a wide variety of reasons; among other things the customers were actually able to employ arbitrage

to the disadvantage of the banks on occasion. At any rate, as a result of these studies, customers were required to take loans in fixed amounts, to repay the loans according to fixed schedules, and to pay interest on the entire amount while they held it. Before this new system could be implemented, it was necessary to forecast the effects of this change in policy. Ridgway's group did a stratified sampling of customers to determine what their behavior would be, and conducted such studies not only at the central bank but at the various branch banks as well.

One of the major issues facing the Bank of Ireland involves service costs. Banking is a service industry and manpower costs are relatively very large. Complicating the situation is the fact that the bank is not free, under terms of the union contract, to lay off superfluous personnel. Typically employees are hired between the ages of 18 and 21 and stay with the Bank until they retire at age 65. This means that manpower planning must be extremely precise. Ridgway's group built a computerized manpower planning model, and the measure of how successful this model has been is that it is now run by the Personnel Department; the OR people have been out of the loop of controlling this model for some years.

A fascinating study about which Ridgway told me considered the management of bullion (actual money, that is notes and coins). The bank's branches are situated both in Dublin and throughout the country. If the money on deposit in those branches can be brought to the central bank it earns interest, but if it remains in the branches it earns nothing. It is desirable, therefore, to bring as much of the money as possible into the central bank, without, on the other hand, leaving the branches with too little money. This appears to be a typical inventory-control problem, but when I asked Ridgway what the cost of a "stockout" would be, he replied that it would be virtually infinite; that is, the management simply would not tolerate running out of money at a bank (if they ran out of a particular kind of money—for example, if they had to give a customer a large wad of one-pound notes when he wanted notes of larger denominations—that would be acceptable, though of course undesirable). There were some complications: stockouts could often be avoided by using soiled money which was being held to be discarded, or even by borrowing bullion from a competing bank. The probabilty that a bank will run out of bullion is not independent of the probability for other banks; in particular, when it is known that a strike is about to take place, there are large runs on all the banks. Furthermore, after the optimal amount of money to have at a given branch has been determined, the funds which the branch bank is holding over and above that amount must be transferred to the central bank. Transporting these funds is always expensive, and in addition leads to the possibility that a robbery may take place (Ridgway enjoined me to state here that it has been some years since any of the OR people in the Bank of Ireland have known anything about the detailed schedules of transporting such bullion.)

A typical OR study done by the Bank of Ireland, and, in fact, by most banks, concerns "asset management," specifically the management of government securities and short-term money. There are government requirements specifying that certain amounts must be held in such securities rather than in loans, but within the regulations it is possible to form an optimization. In discussing this type of study, Ridgway stressed that the contribution of the OR department was often clarification, so that management had a clearer view of its options, rather than actual optimization. The classical techniques of OR, such as linear programming, have rarely if ever been used by this group, and Ridgway commented that if he had to give a lecture on linear programming today, he would have to look the subject up. On the other hand, of course, he has this and similar techniques firmly in mind, as do all good OR people, and he knows just when they would be appropriate, and he is able to select the techniques required by the job at hand.

Turning now to academic OR, there are two universities in the country: Dublin University and the National University of Ireland. Dublin University, of which no one has ever heard (under that name), is synonymous with Trinity College, Dublin, of which everyone has heard. This famous college, founded in 1591, was given its charter as a university by the Act of 1908 (which also established the National University of Ireland), but thus far no other college has been established. Trinity College and UCD are the prestigious institutions in the country. The latter is part of the National University of Ireland, which also includes three other campuses, one of which is the old Queen's College in Cork. In addition, Ireland has a number of polytechnics and other forms of tertiary education short of the university level.

At Trinity College, OR is found in the Department of Statistics, whose head, Prof. S. Gordon Foster, has become dean for a 3-year term; Michael Stuart, a

senior lecturer, is the acting head. Most of the OR courses are taught by Antony Unwin and Trevor Gibbons, both lecturers in the department. Gibbons has a doctorate in theoretical chemistry from the University of Bristol. After receiving his degree, Gibbons went to the Coal Board, where he became interested in OR. Unwin is writing a dissertation on queueing theory to earn his doctorate from Trinity College (working for a doctorate at the school where one teaches is not unusual here, although it would be in the US). In addition to undergraduate instruction in OR, there are several graduate programs: MSc in Statistics and OR, with about 8 students a year; MSc in Statistics and Administration, open to civil servants, many of whom take the same courses as the above; and a "Systems Development Program," which attracts 10 or 12 students from developing countries each year, and which includes many of the courses found in the first two graduate programs. In all of these a major part of the curriculum consists of a project (see *ESN* 32-12:428 [1978]). Two or three students work on the same project and spend essentially the last 3 months of a 12-month course on it. The first 9 months consist of technical and theoretical material, such as that found in the textbook by Wagner, plus a good deal of methodological material, including "Case Exercises," which essentially represent mini-projects leading up to the main project. The department also has a "Statistics and OR Laboratory" which runs projects. Many of these come from other departments of the college, while others come from industry, the EEC, etc. All of the projects bring extra money into the department, some of which can be used to supplement faculty salaries.

UCD was established as a small downtown campus in 1908. In 1962 it moved to a several-hundred-acre campus 4 miles south of the city, and this campus has been expanding rapidly. There are now some 10,000 undergraduate and 800 graduate students studying here, and still further expansion is anticipated. Unlike the US, where the "baby boom" consisted of children born about 1950 who went through the universities about 1970, Ireland has had its population boom quite recently and expects drastic increases in the size of university enrollments in the next few years. OR is found in the Faculty of Commerce, and in particular in the Department of Management Information Systems in that Faculty. The recently appointed dean of the faculty, Enda Hession, has been on the Council of ORSI, and the head of the MIS Department, Harold Harrison has a PhD in Operations Research from Queen's University in Belfast. Thus, there is considerable interest in OR on the part of the administration; however, there is surprisingly little activity as a result of this interest. Much of the teaching is done by Derek R. O'Connor, who recently received a PhD in OR from the University of Indiana and holds the rank of "College Lecturer," a rank which seems to be peculiar to this university, but which corresponds roughly to that of assistant professor. The principal channel of this instruction is a "Master of Management Science" (M. Mgmt. Sc.) program, a 1-year program in which the last several months are spent on a project leading to a formal "dissertation" and a defense thereof. Students work in pairs on these projects. I asked O'Connor whether this was really more efficient than having students work individually and his answer was an affirmative; but the principal reason he gave was that it was just too difficult to dig up and supervise a useful project for every student.

There is also considerable OR in the so-called MBA program, a 2-year program given to students who are working full-time and have several years of experience. I was amazed to discover what a demanding program this is: it has no electives; classes meet 2 nights a week from 4:30 to 7:30 p.m. and two other nights from 4:30 to 8:30 p.m.; and homework apparently is done over the weekend. The Irish appear to be made of sterner stuff than most of the part-time students in the U.S. with whom I am familiar!

O'Connor's research has been on PERT and other related stochastic networks. He is particularly interested in algorithms for calculating the total time required to go through the network. One of the well-known papers in this area is by Kleindorfer, who has set bounds on this time. O'Connor has been able to show that Kleindorfer's lower bound is almost the exact solution. He has also developed new algorithms for finding the total time.

The vice president of ORSI is James Crowley, who holds the rank of college lecturer in the Department of Business Administration in this same faculty (Hession's old department), and teaches courses in transportation with a strong OR flavor.

The Secretary of the Operations Research Society of Ireland is Michael

Hegarty, who received the M.Mgmt.Sci. degree from UCD 2 years ago and now teaches in the College of Commerce, one of the 6 schools which constitute a polytechnic called the Dublin Institute of Technology. Through a complicated arrangement, the degrees in this institute are awarded by Trinity College, but in all other respects it is autonomous. Hegarty told me that he is thinking about coming back to UCD for a doctorate. He is presently doing research on the generalized transportation problem, developing algorithms and finding applications involving energy flows, where conversion efficiencies are the factors that convert the problem from one of transportation to one of generalized transportation. However, from what he told me about this research it seems unlikely that it is publishable, and I believe that very little publishable research gets done in an institute of this type. Nonetheless, it is a surprising fact that even candidates for the BSc degree at such a school do very extensive projects and submit dissertations on them. Each student spends approximately half his time during most of the last year on a project on which he works individually. Failure is not uncommon, and such students have their diplomas withheld while they are asked to rework and resubmit their dissertations.

It is not likely that important new fundamental ideas in the theory of operations research will come out of Ireland. OR is not a major endeavor, and it is not heavily subsidized or heavily emphasized, either in the universities or in the applications-oriented organizations in industry or commerce. Ireland is a small country and the OR being done there is a small-scale effort. Instruction in OR is done more at the technician level than at the scholarly level. The practice of OR is limited primarily to simple problems that are readily amenable to quantification and computerization. A number of the people doing this work are highly competent, and a lot of useful work will continue to be done, but it seems unlikely that a great deal of research leading to new techniques of interest to other countries will come out of this small nation. (Robert E. Machol)

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PHYSICS

THE 4TH INTERNATIONAL CONFERENCE ON SOLID SURFACES

The 4th International Conference on Solid Surfaces was held jointly with the 8th International Vacuum Congress and the 3rd European Conference on Surface Science in Cannes, France, on 22-26 September 1980. This three-part meeting convened under somewhat inauspicious circumstances. Upon arrival, the conference participants were notified that the location of the meeting had been moved from the Palais des Festivals (an elegant edifice) to a large circus tent situated on the parking lot of the Stade P. de Coubertin (a soccer stadium). A week beforehand, the Societe Francaise de Vide (French Vacuum Society—sponsor of the meeting) was informed by the local authorities of the breaking of the contract. Despite 11th-hour efforts to reverse this decision, the local authorities refused to reconsider their position. Apparently, the organizor of the conference commencing the week after the Surface Science Meeting (a video communications event called VIDCOM 80) had scheduled the preceding week for equipment setup. As coincidence would have it, these same people organize the Cannes Film Festival. In spite of appeals from the French Government and heads of scientific and industrial organizations, and notwithstanding the fact that the French Vacuum Society had reserved the premises back in 1977, the local authorities were adamant. Unfortunately, over 1,000 scientists from 37 countries suffered the consequences. Yet despite the (at times intolerable circumstances, the meeting got underway.

To say that the scope of the meeting was broad would be an understatement. There were 343 oral papers, 430 posters, and 10 technical sessions presented in a span of 5 days. Topics were organized along three different lines: Vacuum Science and Techniques, Vacuum Metallurgy, and Thin Films and Surface Science. The proceedings were published in a comprehensive 4-volume set.

The plenary lectures, presented by Prof. J. Friedl, Prof. G. Ertl, and Dr. M. Rodot, were superb events. Friedl (Univ. of Paris, Orsay) presented an enlightening lecture on the experimental and theoretical aspects of surface electronic structures. Ertl (Univ. of Munich) presented a straightforward yet comprehensive plenary lecture on the interactions in chemisorbed phases. Especially exciting were his recent experiments on the vibrational and rotational energy distributions of a molecule (NO) before and after collision with surface [Pt(111)] as studied by laser-induced fluorescence. Dr. M. Rodot (CNRS, Paris) is the top man in the French government responsible for all aspects of Solar Energy R&D. His lecture stressed the more practical aspects of solar photovoltaic energy conversion and associated economics in view of the increasing dependence of countries on imported fossil fuels. He outlined the technological schemes currently used by various organizations to reduce the cost of silicon solar energy cells to a more economically competitive value (ca 1/10 of today's cost). Particular attention was paid to silicon-ribbon production techniques combined with ion implantation and pulsed-electron beam or pulsed-laser annealing.

Some noteworthy sessions were those concerning the correlation of surface chemical composition with surface wear (tribology). In particular, Dr. R.W. Vook (Syracuse Univ.) had designed and implemented a device to characterize the wear tracks in copper slip ring-wire brush contacts by *in situ* Auger spectroscopy. He is currently setting up to do sputter-depth profiling of the wear tracks as a function of the nature of various gas lubricants. Prof. W. Plieth (Free University, Berlin) had presented some interesting *in situ* spectroscopic studies on the electrochemical growth of iron oxide films. He stressed the application of optical spectroscopies to *in situ* studies of catalysis and electrochemistry as opposed to the more conventional, vacuum-based, electron spectroscopies. Several sessions dealt with surface vibrational properties, especially adsorbate characterization by infrared and surface-enhanced Raman spectroscopies. By far, however, the majority of sessions were geared towards the vacuum-based analytical procedures.

A great many talks were devoted to catalysis. Especially interesting was a presentation by Prof. R.M. Lambert (Cambridge Univ.) on elementary catalytic processes on well-characterized surfaces. He concluded his lecture with some fascinating recent studies on the energy distributions of photons and electrons ejected from various surface reactions. Generally speaking, these surfaces involve metals with low work functions and high electron affinities (Ti, Zr, Hf). The topic of ion bombardment and its applications was dealt with in great detail. Although far from truly characterizing an adsorbate-covered surface, the work of such investigators as T. Engel (IBM-Zurich), A. Benninghoren (Univ. of Munster), and N. Winograd and B. Garrison, (both from Pennsylvania State Univ.) demonstrated feasible approaches to the problem from both experimental (He, Ar-atom, ion bombardment and isotope substitution) and calculational (classical Hamiltonian dynamics) points of view. Rapid heating/cooling (10^{13}K/sec) to achieve metastable phase formation was a topic discussed by Prof. E. Rimini (Physics Inst., Catania, Italy). The use of laser and electron beam irradiation of ion-implanted semiconductors and metals was reviewed in great detail as were the mechanisms of alloy formation.

Plasma and ion Beam techniques as applied to deposition/etching of thin films were discussed in a number of lectures. An interesting technique described by K.M. Eisele (Fraunhofer Inst., Freiburg) was that of plasma mass spectrometry for the direct analysis of ions formed in a plasma and its application to plasma-etch processes. A variety of empirical talks/posters concerning plasma deposition of thin films were also presented as well as a number of theoretical discussions concerned with the various models describing chemisorption phenomena.

The conference was concluded with a series of materials-and techniques-oriented lectures and discussions. Notable talks among these were those by J. Bennett (Naval Weapons Center, China Lake, CA) on the effects of defects on the optical performance of thin films, D.M. Mattox (Sandia Labs.) on the mechanical properties of metallic and ceramic deposits, J.K. Sass (Fritz Haber Inst., Berlin) on spectroscopic studies of metal-electrolyte interfaces, and J. Vereecken (Vrije Univ., Brussels) on the use of new techniques to investigate electrocrystallization phenomena.

As things might have it, this "Circus of Cannes" took its motto from the engraving at the Stade P. de Coubertin, "It's not the winning that counts, its the participation." (Richard R. Smardzewski Naval Research Laboratory)

SEMICONDUCTORS IN THE NORTH

Sigtuna, the former capital of Sweden, situated about 30 miles north of Stockholm, was the site of Nordiskt Halveledarmöte 9, the 9th Nordic Semiconductor Meeting, which took place on 11-13 June 1980. Apparently I was the first non-Nordic ever to participate in such a meeting except for a few invited speakers. Among the invited speakers this year were persons from Germany, Hungary, and France. These meetings are not advertised outside the Nordic countries (Denmark, Finland, Iceland, Norway and Sweden), so it was just by coincidence that I found out about them. Prof. P.A. Tove, of the Department of Electronics, Institute of Technology (ITU), Uppsala, the chairman of this year's meetings, was kind enough to permit me to attend.

A number of the Swedes whom I met at Sigtuna told me that spring and early summer were usually overcast and rainy in that country. I had difficulty believing that, for the weather was a sunny 75°F, quite in contrast with what we normally experience in London.

Sigtuna, a charming old town complete with church ruins and rune stones, all neatly arranged, is on the banks of a narrow finger of Lake Mälaren, the lake that is so much a part of Stockholm. The rune stones on display are flat red stones, about 6 feet high covered with chiseled symbols. We were told that they were essentially autobiographical records of influential local personages of long ago. Like most of the Swedish landscape, the country surrounding Sigtuna was lush and green with both meadows and pine forests. Only the mosquitoes that left their marks on us reminded us that nothing in the world is completely perfect.

The technical sessions of the Halvedarmöte were held in the very modern conference center, Sjudarhöjden, surrounded by trees and greenery out of which an occasional huge rabbit could be seen venturing forth without great concern for its human neighbors.

There were about 15 representatives from Finland in attendance, most of whom were from the Helsinki University of Technology or the closely related Technical Research Center of Finland, both located at Espoo. That delegation was led by Dr. T. Stubb, who is both a professor at the university and director of the Semiconductor Laboratory of the center. The Institute of Physics of the University of Oslo had 4 participants. Among the 3 others from Norway was Dr. J.S. Johannessen (Univ. of Trondheim) who is well known to many in the US.

Sweden, the host country, had the numerical edge by far, with 70 delegates. Among these a group from Stockholm included Dr. L. Huldt and others from Physics Department III of the Royal Institute of Technology (RIT); others from Applied Physics and from Applied Electronics of RIT; a group from the closely associated Institute of Microwave Technology, led by its director, Dr. P. Weissglass; and Dr. S.I. Ragnarsson of the National Swedish Board for Technical Development (STU). The host institution (ITU), with Tove, the conference chairman, had the largest delegation. Among other institutions represented were Chalmers University of Technology (Göteborg), the University of Lund, the Linköpings Tekniska Högskola, and members of the Quantum Chemistry Group of the University of Uppsala. I had a chance to talk with Dr. Calais of this group, and in view of his name, I asked the obvious question. The answer was that he was indeed Swedish; his French ancestor had come to Sweden during Napoleonic times. History buffs will remember that the present Swedish royal family stems from Jean Baptiste Bernadotte, one of Napoleon's field marshals. It is said that he became King of Sweden despite the fact that he wore the tattoo "Death for all Kings," which he had acquired during the French Revolution.

Among the Swedish firms represented at the meeting were ASEA, manufacturer of power station equipment, from Västerås; its subsidiary ASEA-HAFO AB, from Järfälla; and RIFA, a subsidiary of the communications equipment manufacturer Ericsson, from Spånga.

Much to my surprise, Denmark had only one delegate, Dr. L.D. Nielsen, of the Danmarks Tekniske Højskole, Lyngby, who discussed ion implanted solar cells and reported that by using large grain polysilicon (as grown) material (obtained from Topsil A/S Denmark) implanted with boron at 3keV through a thermally grown oxide layer, his group had obtained AM1 conversion efficiencies greater than 11%.

Iceland, the fifth Nordic country, has apparently no semiconductor work in progress. The one delegate from that country was actually associated with a group from Lund. There was, however, a contribution from a sixth Nordic country, from Tallinn Technical University, Estonia, USSR. As in so many other cases of contributed papers from the USSR, however, the authors were not able to be present.

The topics among the 40-odd contributed papers covered virtually the entire spectrum of semiconductor physics and technology. Some reported new developments, while others were merely status reports of local work which was not necessarily new on an international basis.

What struck me, personally, as the most interesting development to be reported was a new method of depositing electroluminescent films. This was discussed in 4 papers by T. Suntola and colleagues of the firm of Oy Lohja Ab (02100 Espoo 10, Finland). Entitled Atomic Layer Epitaxy, or ALE, the process, which was said to be surface controlled, is based on sequential surface reactions of each component of a compound. In each reaction step, the surface to be grown is subjected to interaction with a vapor-phased reactant which causes a monolayer coverage. Depending on the substrate and the reactants, highly oriented or amorphous thin films can be produced. The growth rate is not dependent on the rate at which the reactants are introduced provided that in each case it is high enough to give a monoatomic layer on the surface. Thickness is proportional to the number of reaction steps. Atomic layer tailoring, which was said to be simple, can be used to build compound combinations and super-grid structures on glass substrates or single crystals. In a typical deposition, solid ZnS was said to have been produced from vapor phases of $Zn\,Cl_2$ and H_2S. To start such a process, $Zn\,Cl_2$ vapor is allowed to strike a glass substrate heated to 500°C, to combine with oxygen in the glass. When this is followed by H_2S, a monolayer of ZnS results. By repeating the cycle of alternate exposures, films of virtually any thickness desired can be produced. X-ray diffraction of films produced indicated that the ZnS films were hexagonal and highly oriented in the growth direction. In a similar manner, Ta_2O_5 films were deposited; these turned out to be amorphous.

Suntola's colleagues, A. Pakkala, J. Antson, and S. Lindfors, reported that ALE has been used to fabricate thin-film ac electroluminescent devices, using Mn-doped ZnS. Bright, large-area electroluminescent displays, yellow in color, which appeared to be of uniform brightness, were demonstrated to the audience. Epoxy encapsulated displays of this type were said to have operated without loss of brightness for 5,000 hours.

Films produced by ALE were said to be of very high quality, to be stable, to be of uniform thickness over a very large area, and to permit the tailoring of a number of compounds. The chief disadvantage to the process could be the all-important factor of cost, because several hours were required to deposit the necessary thickness for the electroluminescent display.

Among the other contributed papers, a number dealt with components for optical communication systems, and several treated new measurement techniques. Some sessions contained papers on various topics. For example, the theoretical paper, "Charge Distribution and Barrier Heights at Intimate Contacts between Metals and Semiconductors from Cluster Calculations" by E. Sangfelt, J.L. Calais, and O. Goscinski (University of Uppsala, Sweden); "The Contribution Band Structure and Density of States of ZrS_2 and $ZrSe_2$", by H. Isomäki and J. von Boehm (Helsinki University of Technology, Finland); and a review of a method of designing an integrated circuit (IC) using computer-aided design (CAD) were all presented in the same session. A similar mix was found in another session in which both GaAs papers and papers describing measurements on magnetic semiconductors were presented. This mix was understandable, of course, since the number of persons engaged in this work in the Nordic countries was far too few to permit separate sessions on most topics.

The program committee considered some subjects to be of sufficient current interest to invite experts "from the south" to speak about them. These topics were components for optical fiber communication, modeling of semiconductors and devices, semiconductor superlattices, and amorphous silicon.

In the first part of his talk dealing with optical communication devices, Dr. S. Maslowski, (AEG-Telefunken Research Institute, Ulm, FRG) dealt briefly with general trends in optical communication research, such as the work aimed at reducing the number of repeater stations required by moving from the present (experimental) 0.850 μm systems to 1.3 μm (minimum dispersion) or 1.55 μm minimum attenuation, and the development of digital systems to replace analog systems. He stated that the cost of optical fibers is quite high; an important objective therefore is cost reduction. He also singled out optical signal processing in such systems as a challenging field of research.

The main portion of Maslowski's talk however, dealt with injection lasers, i.e. the coherent sources for fiber communication of the future. Since these are discussed in many publications, I do not dwell on details, except to state that he contrasted what he called index-guided with gain-guided striped lasers. He referred to the former lasers as racehorses; the latter as workhorses. Maslowski's company has evolved a V-grooved diode which, not surprisingly, falls into a ga

uided category. The V-grooved structure, e said, was more stable than other sys-ems and had a predicted lifetime at 20°C f a million hours.

Present efforts at AEG-Telefunken re aimed at adapting the V-groove tech-ique to 1.3-1.55 μm lasers, improving etectors for these ranges, and develop-ng other components, such as optical solators.

Prof. K. Tarnay (Technical Univer-ity of Budapest, Hungary) who has been guest at ITU several times, presented review of modeling of semiconductor tructures and devices (modeling for ircuit analysis, physical modeling based n the solving of partial differential quations, and the simulation of differ-nt fabrication processes), including the arious standard computer programs that ave been developed. The published ver-ion of this review should be an outstand-ng resource for workers in this field.

A most interesting invited paper by r. G.H. Döhler (Max-Plank-Institute für estkörperforschung, Stuttgart, FRG) dis-ussed both the general ideas about so-alled man-made semiconductor superlat-ices (SL) and his own contributions to he subject. Structures that fit this escription are now fabricated in a number f laboratories by molecular beam epitaxy MBE). In this process, alternate layers f materials with lattice matching are rown in ultrahigh vacuum at rates of round 1Å/sec.

Döhler distinguished between two ypes of SLs: Compositional SLs, which re a periodic sequence of semiconductor aterials with different energy gaps; and oping SLs, which are a sequence of n- nd p- doped layers, possibly with undoped ayers in between (so-called "nipi-struc-ures"). Some of the characteristics redicted for SLs are very high mobility by suppression of electron-hole recom-ination) leading to very fast devices; egative differential mobility at large lectric fields; and tunability of the nergy gap either optically or by carrier njection into the bulk. Should these ffects materialize successfully, among he applications envisioned are bulk field-ffect transistors, three-dimensional ICs, ight modulators, sensitive radiation etectors, and electroluminescent devices hat are tunable in frequency. While some xperiments have verified theoretical redictions, work in SLs is actually still n the early research stage.

The final invited paper, which dis-ıssed low-cost solar cells, was by D. ıplan (Laboratoire Central de Recherches ıomson CSF, Orsay, France). It dealt ith amorphous silicon prepared by thermal :composition, i.e., chemical vapor deposi-tion (CVD) of silane around 600°C (but less than 650°C), followed by posthydro-genation in a hydrogen plasma. According to Kaplan, because conservation of momentum and energy are not very well defined for amorphous silicon, optical absorption can be much greater than for polycrystalline material. Indeed, he reported that his films have a very stable optical absorp-tion (in the visible range) with an absorption coefficient 2.5 times that found in amorphous films fabricated by the low-temperature glow-discharge method, a result said to be a real gain. Moreover, high n^+ and p^+ conductivities can be obtained. While solar cells fab-ricated from Kaplan's material have so far had efficiencies of only 5%, there is great optimism for improvement in this application as well as for using the material for fast light detection, thin film transistors for flat panel displays, and in xerography.

In addition to the technical meetings, there was another session, conducted partly in Swedish, that was designed to provide an overview of semiconductor research in the Nordic countries. In this session, the representative from STU, Sweden, spoke about an "action program" in which the Swedish government had been asked to fund work in basic semiconductor research; ICs and CAD; optical communication, displays, and imaging; and sensors. The priorities he listed included funding for an LSI/VLSI (large and very large scale integration) processing laboratory, expansion of LSI CAD work, development and characteriza-tion of new materials and processes, and such special projects as charge-coupled device configurations for infrared detec-tion, gas-sensitive sensors, and micro-wave components. Readers may be inter-ested to learn that STU may also authorize some research funding abroad.

The programs discussed by represen-tatives from other countries were some-what less well defined. The speaker from Norway lamented the fact that his country was too small to have a uniform level of competence. He also expressed the belief that Norway was importing too little in the way of microelectronics. His personal recommendations as to the types of research that should be promoted included ICs, sensors, electronics/telecommunications, and GaAs work geared toward applications.

Finland's representative commented that in order for research groups to re-ceive funds from the Finnish Department of Industry, it was necessary to have the support of an industrial firm.

Nielsen, the participant from Den-mark, said that although there was vir-tually no semiconductor physics research taking place in his country, there was a considerable amount of activity in LSI and optical communications.

Finally, we learned that there are several organizations whose mission is to promote international cooperative efforts. These are Nordforsk (Stockholm), which provides about $1.5 million annually in grants; an industry fund, which dispenses about $4 million to $5 million each year (granted if matching funds are provided by industrial firms), and an organization that promotes seminars and short courses. Despite these cooperative ventures, some of the speakers deplored the fact that except for meetings such as the present one, every nation seemed to want to "do its own thing." This is certainly understandable, since there are probably vast differences in the economic situations of the various countries. Norway, for example is presently reaping the benefit of North Sea oil; other Scandinavian countries are in much less favorable circumstances. Nevertheless, I could not avoid concluding from this discussion and from the general tenor of the conference, that more active international cooperation by, say, allocating tasks and areas of interest, would benefit all countries concerned.

In this report I have listed only the technical highlights of the conference. Since it was announced at the meeting that papers would be published in *Physica Scripta*, published in Sweden, readers may wish to refer to a future issue of that journal for details. (Irving Kaufman)

SOME SOLID STATE PHYSICS IN THE NETHERLANDS I

DELFT

A short train ride from Leiden brings one to the picture-book city of Delft, famous for blue glazed pottery and white earthenware. Outside the old city is the Delft University of Technology which has been described recently (*ESN* 34-8:376 [1980]). There I visited the Department of Applied Physics, which has 20 professors, approximately 80 other persons with PhD degrees, and 180 technicians. This group serves about 700 students most of whom are undergraduates or master's degree candidates. Only 25 are PhD students; this is a reflection of the high status of the MS degree in the Netherlands. Usually the MS candidates in that country write a small thesis and take sufficient course work so that attempting to earn a PhD only entails taking several more courses and performing research work to give a thesis acceptable at the PhD level.

Since some of his laboratory was in the midst of extensive remodeling, my host, Professor J.E. Mooij, showed me those portions that were not covered by sawdust and wallboard. During the pa several years Mooij and his colleagues h been working with superconducting microbridges. These are small superconductin regions connecting much larger ones. Typically of the order of less than 1 μm in width, these weak links can be formed by scratching a superconducting film whi has been evaporated on a metallic or nonconducting substrate, or by photoresi techniques in which the optical waveleng are replaced by electrons in order to obtain the desired resolution. Such mic bridges can be easily manufactured in arrays and have low capacitance, an adva tage when interacting with electromagnet radiation. One disadvantage of these devices is that at higher voltages they show a hysteretic behavior which is attributed to formation of local normal regions in the vicinity of the bridge. Another drawback is the fact that, since the inductance is also small, the bridge impedance is almost entirely resistive and is smaller than 1 ohm, which makes it difficult to couple to other devices. For these reasons, Mooij has started to work on tunnel junctions, and the remodel in progress was for construction of a laboratory for their fabrication.

Mooij and his colleague, G.M. Daalma plan to fabricate submicron niobium-insul tor-niobium Josephson junctions (SIS) usi a free-hanging microbridge as a bakeable shadow mask. In this technique, which wa described at the Berlin SQUID meeting (G. M. Daalmans, Paper C1, Second Internation Conference on Superconducting Quantum Devices, West Berlin, May 6-9, 1980) the niobium was evaporated at two different angles of incidence, the junction being formed where the evaporated layers overlapped. Junctions fabricated in this manner have current-voltage curves simila to those of high-impedance point contacts and are stable after thermal cycling. Mooij and Daalmans plan to use these junctions in SQUIDS and mixers operating at 230 MHz.

Later in the day I had a short meetir with Prof. F. Tuinstra, an x-ray crystallographer, who told me that his laboratory was only slightly concerned with classica x-ray crystallography. Their primary interest has been in modulated structures in which the modulation is incommensurate with the lattice spacing. Presumably, any physical property may be modulated; magnetization, (*ESN* 34-7:357 [1980]) charge density, and composition modulatior have been observed. Modulated crystals are interesting from the point of view of fundamental physics since the breaking of three-dimensional periodicity destroys son of the basic assumptions of solid-state

theory. At Delft, displacive modulations are under investigation. In such crystals an atomic position does not exactly repeat from cell to cell; it is given by an average position plus a periodic shift.

It has been known for a long time that Na_2CO_3 has a modulated structure at room temperature. Since this structure has displacive modulation with a wavelength that is different from the lattice spacing, the X-ray powder diagram has extra sets of lines. The structure is known to be pseudohexagonal (α phase) above 763°K, monoclinic (β phase) from 763K to 619.5K, and modulated monoclinic (α phase) below 619.5K.

Elastic and inelastic neutron experiments were carried out by Tuinstra and one of his students, C.J. DePater, at Brookhaven National Laboratory and at the Netherlands Reactor Center, Petten, in which they observed the transition at 619.5K to proceed smoothly and with no hysteresis. They determined the transition to be of second order, and established that the length of the modulation vector changes rapidly with temperature as the transition temperature is approached from below. Near room temperature the amplitude of the modulation vector is nearly constant and the modulation can be approximately described as a harmonic wave. They also found that the behavior of the direction of the modulation vector becomes more ordered as the temperature is lowered. Between 619.5K and room temperature the modulation (which can be thought of as having components q_1, q_2, q_3 parallel to the reciprocal lattice vectors) lies in the plane $q_2 = 0$. Below room temperature the modulation vector becomes more ordered, lying on the line $q_1 + q_3 = \frac{1}{2}$. When the temperature is decreased further, another second order transition occurs at 130K in which the incommensurate modulation suddenly becomes commensurate and locked into the lattice.

These same types of effects were also observed in Rb_2ZnBr_4 which has several orthorhombic phases below the melting point of 723K. In this material the high temperature alpha phase transforms to the incommensurate beta phase at 355K. Continued cooling produces a lock-in transition to the gamma phase at 200K, which in this case is accompanied by a spontaneous electric polarization. This latter transition in which Rb_2ZnBr_4 becomes ferroelectric is different from that observed in Na_2CO_3 which does not become ferroelectric in the low-temperature phase because of the difference in symmetry. Tuinstra and his students intend to continue their study of these effects in other members of the βK_2SO_4 family of which Rb_2ZnBr_4 is a member and to which Na_2CO_3 is closely related.

UTRECHT

Not far from Delft is the city of Utrecht, built around Roman ruins on what was once a navigable branch of the Rhine. Today, this branch which is called the Crooked Rhine is practically unnavigable and the city has become a thriving rail crossroads. The University of Utrecht, founded in 1636, has outgrown the town ar my visit took place in the new buildings located outside the city. Professor A. Schuyft, in charge of the Chemical Thermodynamics Work Group of the Chemist Department, and Dr. J.C. Van Miltenberg who is interested in phase transitions (*Journ of Chem Phys* 70 1064 [1979]) have constructed several calorimeters. One of the latest models measures sample 10 to 20 grams in size in the temperatur range from liquid helium to boiling wate It is computer controlled using the discontinuous heating method in which the enthalpy is measured as a function of temperature and the specific heat values are obtained by fitting and differentiat the enthalpy. Using n-heptane as a test sample, the deviation of measured specif heat from the Bureau of Standard's value was found to be at most 0.6% and general less than 0.3% in the 100-300K range. For this sample the latent heat of fusio was 14.053 KJ/Mole, a deviation of 10 percent from the accepted value, the difference being ascribed to impurities. (See *Journal Royal Netherlands Chem. Soc.* 98 408 [1979])

Van Miltenberg is currently using this calorimeter in a systematic study of linear carbon acids where the number of carbons varies from 6 to 20. It is not feasible to measure carbon acids wit less than 6 carbons because the acids react with the material of the calorimeter. Preliminary results show that all the linear carbon acids with odd numbers of carbon atoms undergo a transition.

Another item of interest to a physi cist is a combined torsion weighing-effusion apparatus for measuring vapor pressure in the 0.1P (10^{-3} Torr) range as a function of temperature. Use of th Clausius-Clapeyron equation with vapor pressure data and some assumptions about the nature of the vapor is a standard method of obtaining the latent heat as a function of temperature. One way of determining the vapor pressure is by Knudsen's method in which a solid is placed in an isothermal container sealed except for a small orifice. The rate of mass loss can be measured and is proportional to the pressure. In addition, the gas effusing through the orifice provides a small reaction force on the container from which the vapor pressure can also be determined. This force

can be measured by suspending a container with two holes on opposite sides as a torsion pendulum. If the pendulum is allowed to rotate, however, hysteretic effects become important. To prevent this, the the pendulum is placed in a transverse magnetic field and a small current-carrying coil attached to the container is used to null the deflection. This apparatus uses both methods simultaneously with a resultant difference in the latent heats of 1 to 2 percent. Some recent published results (*Journal of Chemical Thermodynamics* 12 243 [1980]) give the enthalpies of sublimation of 11 polycyclic hydrocarbons. Another report on 2,2'-bis-1,3-dithiole(TTF), 7,7,8,8-tetracyanoquinodimethane (TCNQ) and TTF-TCNQ has been submitted for publication.

X-ray structural analysis of organic materials is also carried out in the Chemistry Department. A recent report on the structure of $C_{22}H_{35}N_3O$ at 183K shows that it is triclinic. The data were analyzed with a computer to provide one-and-one-half pages of results of: lattice parameters and angles, atomic coordinates, atomic bond lengths, and torsion angles.

In a building near the one that houses the Chemistry Department is the Fysisch Laboratorium. There I visited Professor H.W. deWijn who told me about his work with two-dimensional antiferromagnets of which tetragonal K_2MnF_4 and its isomorphs are well-known examples. The ordering temperature (T_N = Néel temperature) is 42.1K for K_2MnF_4 and T_N = 97.1K for its isomorph, K_2NiF_4. Since the register of succeeding layers is staggered, the exchange energy between nearest neighbors is at least 100 times greater than that between next nearest neighbors and, as a result, these systems are almost ideal two-dimensional (2D) Heisenberg antiferromagnets. These are "pure systems" whose properties are relatively easy to calculate, and experimentally the fluorine resonance provides an excellent magnetic probe. deWijn and his students have measured resonances and relaxation times in K_2MnF_4 and K_2NiF_4 and have shown that these are examples in which, as a result of symmetry, relaxation of the magnetization takes place by 3-magnon (quantized spin wave) processes unobscured by 2-magnon processes. More recently, (*Phys Rev B* 21 1963 [1980]) experiments have been carried out in which Zn, Mg, and Ni atoms have been substitutional impurities (up to $\sim$ 2%) for the Mn atoms. They have determined the exchange energies for the pure and substituted systems and conclude that the results of substituting a nonmagnetic atom for a magnetic one has a very local effect.

Another antiferromagnetic material studied is $K_3Mn_2F_7$ (T_N = 58.3K) which has a behavior between that of a 2D antiferromagnetic system such as K_2MnF_4 and a 3D antiferromagnetic system $KMnF_3$ (T_N = 88k). In K_2MnF_4 the antiferromagnetic ordering of spins takes place in the base plane which can be visualized on a unit basis as the ordering of spins located at the corners of a square. In contrast, the ordering in $K_3Mn_2F_7$ is that of double layers which can be visualized as the ordering of spins at the corners of cubes attached to the base plane. Results of NMR and other experiments indicate that the ordering of the double layers is more two-dimensional than three-dimensional at temperatures well below T_N. Above T_N the behavior is found to have 2D characteristics, but the regime has less extent in temperature than that of the single layer material. These materials are considered to be well understood and further work is not contemplated.

EINDHOVEN

In the south of the Netherlands, 15 miles from the border with Belgium, is Eindhoven, now the fifth largest city in the Netherlands. Unlike many of the Dutch cities, it is quite new; its growth from a village began in 1895 when the Philips Company opened a factory for the manufacture of light bulbs. The Eindhoven University of Technology is housed in modern buildings just a short walk from the railway station.

Dr. A.R.A.M. deWaele and Dr. G.M. Coops whom I visited have been working on low-temperature dilution refrigerators since 1976. Operation of a ^{3}He-^{4}He dilution refrigerator depends upon the different properties of each constituent. They have different vapor pressures and different osmotic pressure, and at sufficiently low temperature a mixture of ^{3}He-^{4}He which has condensed into a liquid spontaneously separates into two phases, one rich in ^{3}He, the other in ^{4}He. Since the ^{3}He-rich phase is less dense, the two liquids separate with a horizontal boundary between the bottom ^{4}He-rich liquid and the upper ^{3}He-rich liquid.

A conventional circulating dilution refrigerator has a mixing chamber, a still, and a set of connecting heat exchangers. Cooling in the lower mixing chamber is accomplished by causing ^{3}He atoms from the ^{3}He-rich phase to cross the phase boundary to the ^{4}He-rich phase. The mixing chamber is connected through a set of heat exchangers to the upper and warmer still chamber. Since the vapor pressure of ^{3}He is much greater than that of ^{4}He, pumping on the still tends to evaporate almost pure ^{3}He

which can then be recirculated. Removing ^{4}He from the still causes an osmotic pressure to develop across the phase boundary in the mixing chamber and provides the driving force for the ^{3}He atoms to cross this boundary. The entire two-phase region of this mixture lies below 1K and therefore it is usual, in order to achieve good performance, to locate a pumped ^{4}He bath precooling stage operating at 1.0-1.2K above the still.

Coops and deWaele have been designing, building and operating nonstandard refrigerators. An early refrigerator design was one that dispensed with a pumped ^{4}He bath, instead utilizing only the 4.2K bath (*Cryogenics*, March 1977, pp. 175-177). This was accomplished by designing a special ^{3}He heat exchanger and pressurizing the ^{3}He coming into the mixing changer. The design is claimed to simplify construction and to be especially suited for use in cryogenic experiments of long duration.

In an effort to reach temperatures below 4mK in a continuously operating refrigerator, designs have been developed using multiple mixing chambers. A recent publication (*Cryogenics*, November 1979, pp. 659-665) describes the operation and engineering calculations for double and triple refrigerator mixing chambers, whose advantages become apparent at the low temperature end of the operating region. The triple mixing chamber machine reached lower temperatures and had greater cooling power (heat load into the final mixing chamber) than a device with one or two mixing chambers. It achieved a minimum temperature of 4mK compared to a minimum temperature of approximately 10mK achieved using a single mixing chamber. In the higher temperature region above approximately 12mK the functioning of the triple chamber configuration as shown by the cooling power versus temperature curve is the same as for the single chamber.

The cooling power of a conventionally sized dilution refrigerator is a few microwatts, a typical set of operating parameters being 5μW cooling power at 45 mK temperature with a circulation of 28 μmoles/sec of ^{3}He. Increasing the flow rate will increase the cooling power, and a recently developed large refrigerator achieves a cooling power of slightly over 100mW at the same temperature. To attain this large cooling power the circulation rate of 0.95m moles/sec was required.

Superconducting machines have also been investigated by the pair. They designed and had built a homopolar generator utilizing a superconducting magnet. Constructed at the university, the magnet is wound with 0.5mm diameter NbTi wires, each composed of 90 individual strands. The 11,335 turns are wound on a form with a 37.0cm bore and a 13.0cm length. Operation at 88 amps. gives about 1 million ampere-turns which result in a maximum field of 5.7 T. Approximately 8 liters of liquid helium are needed to cool the magnet coils; subsequently the liquid helium consumption is approximately 25 liters per day. Contacts to the rotating disc are made by a graphite brush whose pressure on the disc is an important operating parameter. More than one disc can be attached to the shaft with a corresponding increase in performance. The output of the device with one disc, used as a generator, is 2500 amps at 4 volts. (John R. Neighbours)

SOME PHYSICS IN LEIDEN

In 1575, William the Silent, the founder of the Dutch Republic, established the University of Leiden as a reward to the city for its heroic defense against a siege by the Spanish. During the succeeding years the university became famous as an exponent of the philosophy of humanism and, since the mid-19th century, it has been renowned for its achievements in science, notably physics. It was here, in July, 1908, that Heike Kamerlingh Onnes first liquefied helium and that he first observed superconductivity in 1911. Today the building in which he worked, now named the Kamerlingh Onnes Laboratorium, continues to house research in cryogenics and solid-state physics.

Cryogenics

The low-temperature laboratory, including the Kamerlingh Onnes Museum, was shown to me by Prof. W.J. Huiskamp who has long-time interests in cryogenics and magnetism. One of his recent PhD students, Dr. R. Hunik, has recently completed his dissertation on two-stage nuclear refrigeration using enhanced nuclear moments.

In demagnetization cooling, a spin system in thermal contact with a low-temperature bath is partially oriented and therefore lowered in entropy by application of an external field. Then the system is isolated from the bath and the external field is removed, and since in this regime the entropy is a function only of the ratio H/T, the temperature is forced to fall in order to keep the entropy constant. That is, the populations of the levels made nondegenerate by the external magnetic field do not change, but rather the level spacing decreases as the magnetic field decreases corresponding to a different Boltzmann

distribution and therefore a lower temperature. In this process the critical parameter is the ratio of magnetic to thermal energy μH/kT which should be relatively large at the beginning of the process in order to obtain an appreciable reduction of entropy. Its value is limited by the value of the magnetic moments, the maximum external field that can be reached, and the starting temperature. Another critical point is the fact that when the external magnetic field is removed, the final value of field experienced by the spins is not zero, but is rather the internal field due to the spins themselves. This final field value is determined by the magnitude of the dipole-dipole interactions between spins and by their spacing.

In conventional magnetic cooling experiments, the above steps have been utilized in a cascade; the first involves a set of electronic spins in a paramagnetic salt starting from the lowest obtainable bath temperature. The cooled salt is subsequently used as a temperature bath in a second cooling stage in which a nuclear magnet is employed. For several years it has been realized that in some rare-earth intermetallic compounds containing rare earth ions in singlet ground states, the hyperfine enhancement of the field at the rare-earth nucleus can be used to obtain more effective nuclear magnetic cooling. The experiments by Hunik are the first in which a metallic nuclear-enhanced compound is used in the initial stage of refrigeration. As a result of cooling this material with a ^{3}He-^{4}He dilution refrigerator, a large cooling power has been attained at a few mK. As a first stage of refrigeration, 3 moles of $PrCu_6$ were demagnetized, producing a final temperature of 2.2 mK after seven hours. This resulted in a relatively large reservoir since with a heat leak of approximately 151 nw, the system took just under three days to warm to 10 mK.

These results were for the first stage only. With a nuclear stage consisting of 8 moles of In and with the associated holders and thermometers attached, the final temperature reached by the In was higher—approximately 10 mK—corresponding to an entropy reduction of 17.5 J/K. Decoupling of the nuclear stage and its subsequent demagnetization resulted in a final temperature of 0.88 mK from which warming to 2 mK took approximately 64 hours.

Experiments were also performed in which $PrIn_3$ was used as the first stage of refrigeration. This material was determined not to be satisfactory if the final temperature required was below 1 mK. This inadequacy was attributed to the enhanced interaction between the Pr nucleii via the exchange coupling between the electronic moments of the Pr ions.

Spin Glasses

Other work was described by Prof. John A. Mydosh, head of a group consisting of five PhDs, and four technicians. Mydosh told me about his experiments on "Spin Glasses," a term originated by B.R. Coles of Imperial College, London, to describe the low-temperature state of some noble transition-metal alloys, although it has now taken on a wider significance. Prototype spin glasses are AuFe and CuMn with low concentrations of transition metal added. At present at least 25 different metallic-alloy systems have been characterized as spin glasses with magnetic concentration ranging between 50 ppm and 10 at. percent. Below this range is the single-impurity or Kondo regime, while above it is the regime characterized by giant clusters in the spin-glass matrix. Measurements of the local hyperfine fields show that at low temperatures the spin directions of the randomly located magnetic ions are locally frozen over long periods without an average long-range order. That is, locally, several spins might stay aligned for some long period with no apparent correlation with another locally aligned group of spins at a distance.

In 1972 Mydosh and Cannella reported accurate magnetic susceptibility measurements on AuFe alloys which showed a sharp cusp in the susceptibility as a function of temperature. This suggested a phase transition, but there was no accompanying change in the specific heat. Designating the temperature at which the cusp in the susceptibility occurs as T_o, other magnetic effects observed were an asymmetry in the magnetization diagram and magnetic remanence when a spin glass was cooled below T_o in a constant magnetic field. (That is, the alloy remembers that it has been cooled in a large field and attempts to keep this frozen in memory, but a much smaller, oppositely directed field is able to cause an abrupt reversal of the magnetization.)

As a result of these and other experiments, the term, "spin glass," has been broadened to include a system which (1) has a low-temperature state that shows frozen magnetism but not long-range order; (2) has a cusp in the magnetic susceptibility as a function of temperature (transition temperature), but no sudden variation in the specific heat; and (3) shows magnetic remanence at low temperatures.

At Leiden, Mydosh has continued this type of measurement. Recently, he and his co-workers have measured the low-field ac magnetic susceptibility of dilute CuMn powders with up to 1.48 At % Mn [*Journ. Magnetism Magn. Mat.* 15-18, 141 [1980]). They used lock-in amplifiers to measure the in-phase and out-of-phase components of the magnetic susceptibility for driving frequencies between 1 Hz and 10KHz. Typically, driving amplitudes were always small, approximately 1 Oe, and the out-of-phase component was always approximately 1% of the in-phase component. The measurements showed an increase in the transition temperature with manganese composition (12.4 K with 1.48 At % Mn) and were independent of the frequency of the driving field. In addition, the experimental in-phase susceptibility curves were independent of whether the sample was, or was not, cooled in a zero magnetic field.

Another spin glass on which they have experimented is Pd + 35At% Fe with small amounts of Mn. Magnetic susceptibility measurements of this material with 5 atom percent manganese have shown 2 transitions: a paramagnetic-ferromagnetic transition at 9 K and a ferromagnetic-spin-glass transition at 2 K. Recent measurements of the low-temperature thermal expansion of this alloy showed it to be considerably larger than that of pure palladium. This result, along with a similar behavior of the specific heat of this alloy is attributed to the wide variation in the manganese-manganese separation distance. It is interesting to note that in these measurements there is no evidence of a spin-glass type of freezing in the temperature region near 2 K.

Many intermetallic compounds of composition REX_2 or REX_3 (RE = rare earth, X = 3d element) crystallize in the Laves phase structures which have the cubic $MgCu_2$ and the hexagonal $CaZn_3$ structures respectively. These structures are the most abundant structures of intermetallic compounds and provide very effective packing of different size ions. They often have high ferromagnetic or ferrimagnetic Curie temperatures(to 1000 K) which characterize the alignment of 3d spin, and show ordering of the rare-earth spins at much lower temperatures. In the compound, the magnetic moments of both the rare-earth ions and 3d ions have been found to be lower than the respective metallic elements, a fact which has been explained as partial quenching of the orbital contributions by crystal fields comparable to or larger than the exchange fields. Mydosh and his collaborators recently have performed magnetic susceptibility, specific-heat, and electrical-resistivity measurements on the same samples of PrX_2 where X = Ir, Pt, Rh and Ru. These experiments showed values of the Curie-Weiss temperatures obtained from the susceptibility to be in the 7-35 K range depending on the compound and corresponding anomalies at the Curie-Weiss temperature in the other measurements. As expected, these data can be interpreted as magnetic ordering of the partially quenched Pr^{+3} ion. However, the specific heat peaks fo $PrIr_2$ and $PrRh_2$ appear to be relatively broader than expected and are unaffected by external magnetic fields. These results are being submitted for publicati

Resonance

Another set of experiments was described by Prof. N.J. Poulis, a long-time researcher in resonance, who first published results on the low-temperature ordering of $CuCl_2 \cdot 2H_2O$ in 1948. Poulis has been at the laboratory since that tim continuing to devote much of his research work to studies of copper salts. For the last five years he has studied linear chains, triclinic $CuSO_4 \cdot 5H_2O$ being a recent example. In this material the copper ions at the (0,0,0) sites act paramagnetically; those at $(\frac{1}{2},\frac{1}{2},\frac{1}{2})$ sites form antiferromagnetic linear chains. Poulis uses nuclear magnetic resonance to study the proton resonance of the hydrating molecules. The proton experiences both the external magnetic field and the dipole magnetic field of th copper ion so that determining the resonance frequency gives information about the copper dipole field. The result is that along these linear chains the antiferromagnetic transition is found to occur at approximately 100 mK.

The special system $Cu(NO_3)_2\ 2\frac{1}{2}H_2O$ in which pairs of copper ions are located close together and therefore couple has also been studied. In this material the coupled pairs of spins can align in either antiparallel (singlet state) or parallel (triplet state) positions. At low temperatures the copper ions are all in the singlet state, which is diamagnetic, but as the external field is increased the levels cross and one of the triplets becomes the lowest energy state. As a result, at an applied field of 36 k this salt becomes paramagnetic.

In other work, Poulis and his students are studying HfV_2 and ZrV_2. Both of these C15 structure materials absorb hydrogen; HfV_2 absorbs enormous amounts—up to 4 or 5 hydrogen atoms per unit cell. Although the absorption mechanism is not completely understood, resonance studies show that it drasticall changes the nuclear quadrupole interactio

Interstellar Dust

Not all the "Physics at Leiden" takes place in the city. On the outskirts is the Huygens Laboratory which is housed in a modern, 8-story building. There, I visited an old friend, J. Mayo Greenberg, director of the Laboratory Astrophysics Workgroup composed of 11 persons including the secretary and a technician. Long interested in scattering, Greenberg had been head of the Astronomy Department at State University of New York, (SUNY) Albany, and was instrumental in setting up the Microwave Analogue Laboratory for Particle Scattering at SUNY. His interests were in the theoretical considerations of the measure of interstellar light. Because of the great difficulties encountered in determining the size and shape of the scattering particles from measurements of the scattered waves, the laboratory was set up to a scattering analogue; replacing visible light with 3 centimeter radio waves—a ratio of wavelengths of about 10^5. Therefore, in those experiments the scattering particles could be about 10^5 larger and were relatively simple to manufacture, and it was possible to build up a library of scattering functions for different oddly-shaped scatterers.

These studies led naturally into the questions of composition, size, distribution, and shapes of the interstellar medium which are the subjects of much of this group's present work. Greenberg said that starlight is observed to be polarized and to have an intensity as a function of wavelength which varies with the distance of the star. These effects are thought to be the result of the passage of starlight through the asymmetric particles which somehow are aligned and which make up the interstellar medium. The mechanism by which the particles are aligned is unknown but is thought to be a result of interaction of the particles with a weak magnetic field which permeates interstellar space. Greenberg pointed out that although the shapes of these particles are uncertain, it is their initial deviation from sphericity that is important.

His group's interest has been on the interstellar grains which are thought to be small, rod-shaped objects. These are believed to consist of a core of silica with a diameter of approximately 0.1 μm covered by a mantle approximately 0.1 μm thick. The length is unknown but is relatively unimportant. The cores are thought to originate as dust ejected from cool stars or nova and originally to be quite elongated. Deposition of the mantle would tend to make the scatterers less asymmetric but never spherical. Formation of the mantle is believed to be by accretion as opposed to the formation of the core which is believed to be by condensation. It is assumed that the material forming the mantle has the same distribution of elements as the cosmic abundance. Bombardment by UV and other radiations is thought to cause the formation of various mantle substances.

In addition to extinction and polarization effects, the infrared spectra of stars shows absorption peaks and bands which are attributed to the material of the mantle. Many of these in the 2 to 15 μm band are expected to result from organic molecules. Recent experiments by Greenberg and his co-workers have shown that a solid mixture of H_2O, CO, CH_3OH, and NH_3 at a temperature of 10 K reproduces many of the shapes and peak positions of the observed interstellar spectra. The features are identified with a vibrational mode of specific characteristic groups of molecules strongly perturbed by the solid environment. They have found that all the major features of the interstellar spectra except the 10 μm silicate absorption agree with those in the spectrum obtained in the laboratory.

Other experiments are concerned with the origins of the materials in the mantle. An experimental system has been developed which creates the relevant interstellar analogue conditions leading to the formation of a wide range of molecules and their injection into interstellar space as a consequence of the evolution and photoprocessing of grain mantles. Within a high vacuum system a suitable gas mixture is deposited on a cold (10 K) substrate. After deposition, the frozen gas mixture is subjected to vacuum UV radiation which causes photochemical reactions, such as the formation of radicals in the bulk of the material. When the cold sample is allowed to warm, the stored reactive species formed during the photolysis react and give rise to luminescence. Simultaneously as the temperature of the substrate rises, various components of the mixture evaporate. These processes are monitored with infrared absorption spectrometry, mass spectrometry, UV spectrometry, and the observation of phosphorescence and chemiluminescence.

These experiments show that radicals are created and stored in the low-temperature complex by ultraviolet radiation, that reactions occur among the radicals and the molecules in the solid, and that stored chemical energy when released leads to evaporation of the grain mantles by internal heating.

In addition, as a result of the above processing, the shape and position of the astronomically observed 3.1 μm band was duplicated in the laboratory.

My visits to some of the different physics groups at the University of Leiden were all detailed and engrossing, but certainly I did not see the entire range of activities. However, on the basis of my experiences, it is clear that physics research there continues in the high tradition set by Kamerlingh Onnes. (John R. Neighbours)

PHYSIOLOGY

THE 7TH SYMPOSIUM ON UNDERWATER PHYSIOLOGY

The 7th Symposium on Underwater Physiology, held at the Hilton Hotel in Athens, Greece, from 5-10 July 1980, drew about 350 attendants. The Undersea Medical Society and the European Undersea Medical Society both held their annual scientific meetings in conjunction with the symposium (on the 5th of July and the afternoon of 10 July respectively). The 7th Symposium itself was organized as a satellite meeting of the 28th International Congress of Physiological Sciences, held the following week in Budapest.

With few exceptions, the various sessions during the week in Athens, emcompassing nearly 100 scientific papers and over 60 poster presentations, were well attended despite the attractions of the Mediterranean climate and the lures of both ancient and modern Greece.

Continuing as sponsors of the Underwater Physiology Symposium Series were The University of Pennsylvania, The Undersea Medical Society, Inc., The US Office of Naval Research, and the US National Oceanic and Atmospheric Administration. The chairman ofthe 7th Symposium governing board, Dr. Arthur Bachrach (Naval Medical Research Institute, Bethesda, MD) announced that all but one of the papers had been submitted in completed form and the first batch was already in the hands of the publishers. So it appears that the full proceedings will be available within six months (at which time they will be available through The Undersea Medical Society, 9650 Rockville Pike, Bethesda, MD 20014).

The first day was devoted to the Undersea Medical Society Annual Scientific Meeting and included sessions on decompression (table development and testing at sea level and at altitude, diagnostic problems in dysbaric osteonecrosis, oxygen effects, decompression during pregnancy), hydrostatic pressure (evaluation methods, drugs under pressure, biochemistry), and oxygen (biochemistry, pathology, prevention, performance). Additionally a wide variety of topics were addressed in two poster sessions (treatment of cerebral gas embolism, fitness to dive, bubble studies, monitoring of divers, immersion and pulmonary function, and thermal problems to name just a few).

The 7th Symposium opened on the 2nd day with a session on oxygen toxicity after a review of current concepts in this area by Dr. James Clark. There were papers on mechanisms of toxicity, biochemistry, effects of oxygen levels maintained during saturation dives, and attempts at prevention, among others. Morning poster presentations included boards on the theme of psychomoter performance and high-pressure nervous syndrome (HPNS) (measuring tremor, narcosis theory, genetic susceptibility to HPNS, deep-diving selection techniques, and sleep electroencephalograms [EEGs] under pressure); and the theme of cardio-respiratory effects (uneven ventilation, arrhythmias, cardiac regulation, the diving reflex, head-out immersion studies). At noon Dr. Peter Bennet showed a film of the recent and remarkably successful 650-meter dive conducted under his direction at Duke University's F.G. Hall Environmental Laboratory. This dive was a little deeper than any comparable dive that was reported in the winter 1979 issue of the US Navy diver's magazine *Faceplate*. The interest in this achievement was evidenced by a large attendance at both the "PR" film and Dr. Bennet's scientific presentation later in the week. Further results from the continuing Atlantis series of dives at Duke will undoubtedly be awaited with even more interest.

The first afternoon session on 7 July was titled "Oxygen Sufficiency and Utilization Within the Cell" (all afternoon sessions began at 3 p.m. following the Greek tradition of closing up shop for a "siesta" in the heat of the day, between noon and 3 or 4 p.m.; accordingly the meetings went on until 7 or 7:30 p.m. each night). A review of current concepts by F.F. Jobsis was followed by papers on chemoreceptors, capillary distribution and circulation in skeletal muscle, retinal oximetry, and mechanism of hyperbaric oxygen effects on staphylococcal osteomyelitis.

The second session, with the lead review paper given by Dr. Paul Webb, was on metabolism and thermal physiology.

Presentations were given on heat-stress analysis, and metabolic and respiratory thermal balance. Three different poster themes also ran throughout the afternoon. The first was on the molecular and cellular effects of hydrostatic pressure, the second on inert gas exchange and decompression (table modeling, pulmonary-gas flows during decompression, gelatine-bubble studies), and the third on health hazards (otitis externa, accident epidemiology, resuscitation techniques for use in a bell).

The next day, 8 July, opened with a review of molecular and cellular effects of hydrostatic pressure by A.G. MacDonald followed by half a dozen papers which complemented the previous day's poster presentations. The afternoon consisted primarily of a session on high-pressure nervous syndrome highlighted by an extremely lucid review by Dr. John Hallenbeck. This session also featured Bennett's paper on rapid compression with trimix (Duke University's record 650-meter dive) plus papers on general anesthetic effects on post-synaptic responses, brain dopamine concentrations in HPNS, prevention pressure effect on lipid-protein interactions and on vertebrate neuron electrophysiology, evoked responses, and differentiation of HPNS convulsive components. Afternoon posters included two on thermal physiology (energy/fluid balance during saturation diving, computer model to predict diver temperature changes) and several more on oxygen toxicity (protective agents, high oxygen effects on the lung filter, scanning electron microscope pulmonary observations, biochemical changes, and the influence of inert gas concentrations on pulmonary oxygen toxicity).

On Tuesday evening, most attendees were taken by bus 6 miles south of Athens to the National Yacht Club of Greece in Piraeus, for the symposium banquet. Piraeus is just one of the numerous seaside satellites within easy drives from Athens (to which the wise Athenians generally retire in the summer we were told, although when I went back for another visit at the end of the week, the boulevards and terrace cafes of this picturesque port were all but deserted). Many of us did not realize until we were told, that not only is Piraeus one of the major ports of the Mediterranean, but it is also famous as the waterfront where the movie "Never on a Sunday" (with Melina Mercouri) was made. At any rate, the view from the Yacht Club, overlooking the Aegean in one direction and Athens with her lighted Acropolis in the other, was entrancing (the festive atmosphere also owed much to the unlimited wine and the impromptu Greek folk dancing by Dr. Chryssanthou in which he got everyone within reach to join).

The next day, 9 July, opened with a morning session on cardiorespiratory responses to exercise with the review paper, given by Dr. L. Fargraeus, follow by papers on exercise metabolism at pressure, ventilatory measurements, carbon-dioxide retention, and maximal aerobic power during a 31 ATA saturation dive. The afternoon was free for individual plans and the Undersea Medical Society (UMS) Business Meeting and Award Luncheon (which will be fully covered in a forthcoming issue of *Pressure*, the UMS newsletter).

The morning of the final day, 10 July, was taken up by the last sessio of the symposium, titled, "Inert Gas Exchange and Decompression". The review of current concepts was given by Paul Weathersby and papers included the following topics: Saturation-decompression modeling, surface decompression for helium-oxygen dives, Doppler monitoring, untrasonic-imaging techniques, lung surfactant and pulmonary air emboli, and prevention of decompression sickness by drugs.

As mentioned earlier, the afternoon of 10 July was organized as the Europe Undersea Biomedical Society (EUBS) Annua Scientific Meeting. Papers in this session, entitled "Health Hazards", were aimed at the clinical diving physician (and will be published in the proceeding of the 7th Symposium, I understand). Dr. Joseph Farmer gave the opening revie paper which was addressed to current con cepts of aural barotrauma. Papers followed on mechanisms of aural barotrauma, waterborne microbial pathogens, and salvage of toxic chemicals using saturation-diving techniques. A second review paper on current concepts in bone necros research was given by Prof. Dennis Walde and the final three papers covered abnor mal collagen metabolism in experimental dysbaric osteonecrosis, a diver's radiological and histological survey, and studies on spinal anesthesia at pressure

After this last scientific session, the EUBS held its annual general meeting chaired by the president, Dr. David Elli Approximately 50 members attended the meeting. The society's healthy financia position was verified by the treasurer's statement and the good news was that the annual dues would still only be £5 sterl for the coming year. It was announced that the proceedings from the meeting he in Bergen last year were finally complet and would be mailed out shortly. The following are details of future EUBS mee the Annual EUBS Congress (and Symposium

on Decompression Sickness) will be presented by the North Sea Medical Centre, Great Yarmouth, UK, from 21-24 July 1981, at Churchill College in Cambridge, England (it will be approved for 15 category-1 CME credits through the UMS). Coach tours, visits to other colleges, and a traditional Elizabethan Feast will all be featured on the social program. Abstract forms and registration information are available from Dr. N.K.I. McIver, North Sea Medical Centre, 3 Lowestoft Road, Gorleston-on-Sea, Great Yarmouth, Norfolk, UK. Preliminary information is that the 1982 EUBS meeting will probably be held in Germany (possibly in Lubeck where the Naval Medical Research Institute situated there will be celebrating its 50th anniversary). 1983 is less certain, but a possibility is Barcelona, Spain.

EUBS officers and executive committee members for 1980/81 are: immediate past President, Dr. Pierre Fractus (France); President, Dr. David Elliot (UK); Vice-President, Dr. Tor Nome (Norway); Secretary, Dr. N.K.I. McIver (UK); Treasurer/Membership Secretary, Dr. Tom Shields (UK); Members-at-large, Dr. Hans Ornhagen (Sweden), Dr. Eivand Hansen (France), Dr. J. Nelson (UK).

A final note: there was a short, informal, and unscheduled thermal meeting held at lunchtime on 8 July, open to any interested parties. Some problem areas briefly discussed were: What are the behavioral and physiological problems associated with partial loss of hot water to a diver and long, slow cooling (vice total hot water loss and rapid cooling)? What guidelines can be given for assessment of thermal balance in a diving chamber (for example, to determine whether a diver is fit, from a thermal viewpoint, to go for a second or third excursion out of a bell)? What further direction should studies take on the question of thermal problems in a lost bell or a hyperbaric lifeboat?

It was the concensus that work in these areas is important and of immediate concern and that a workshop some time next year would be of value. It was also mentioned that the Diving Medical Advisory Committee of the United Kingdom might be invited to cosponsor a thermal meeting in the not-too-distant future, focusing on the following areas, among others: (1) the question of whether marginal hypothermia predisposes to loss of consciousness underwater (this also relates to a separate workshop UMS will be holding on loss of consciousness); (2) methods of determing performance decrements in early hypothermia (and in slowly developing hypothermia); (3) Methods of education of diving supervisors.

In summary, the three separate meeting held in Athens from 5-10 July, were well attended and proved very valuable. Due to space restrictions it was only possible here to briefly mention the many topics that were addressed; however, full proceedings were expected to be available by Christmas, and for those who desired more information before then, a 96-page booklet of program, abstracts, and mini-papers was included in each attendee's registration fee. Undoubtedly the UMS offices would part with any excess for a small stipend.

My only regret upon leaving Athens was that after seeing a few of the city's ancient temples, statues, and ruins, one became aware that, as in Rome, these marble treasures are deteriorating at a rapid rate. In a city designed for 200,000 but now numbering over 3 million, urban pollution, principally in the form of motor vehicle exhausts, is the enemy. The fumes mix with rain to form an acid that pocks and ruins the marble. The standing joke, that the taxi fumes threaten to topple the Acropolis any time now, did not seem at all funny on the last day we were in Athens, when a sudden humidity rise and temperature inversion made us anxious to leave, taking our watering eyes and burning lungs with us. The elements by themselves should not turn the ancient Athenian monuments to dust for a few thousand more years, but if you believe archeologists (that at the present rate of decay, recognizable details on most major outdoor works will be gone in 2 to 3 more decades), perhaps you should visit Rome and Athens now. (Robert F. Goad, Exchange Office, Underwater Medicine Inst. of Naval Medicine, Alverstoke, Gosport, Hampshire, UK)

PSYCHOLOGY

INTERNATIONAL CONGRESS OF PSYCHOLOGY

The International Congress of Psychology meetings are held every 4 years under the auspices of the International Union of Psychological Science (IUPS). The 22nd International Congress was held on 6-13 June 1980, at Karl Marx University, Leipzig, East Germany. The president of the 22nd Congress was Dr. Friedhart Klux, a professor of psychology at Humboldt University, East Berlin.

There were 4,000 registered participants at the meetings representing over 50 countries. Almost half of the participants were from communist-block countries, with 1,300 from East Germany alone. While the congress planners had anticipated over 1,0(American attendees, only 200 actually

registered and were able to attend. Nonetheless, the US had the third largest block of participants, exceeded only by East and West Germany.

Leipzig is a town of only 300,000 residents, and strained under the influx of congress participants. However, extensive advanced planning was evident and that, along with the excellent assistance of a mass of students from surrounding universities, resulted in a smoothly run convention.

Almost all of the meetings took place in a central building at the university. Because of the size of the congress, there were anywhere from 17 to 22 simultaneous meetings each morning and afternoon. The half-day meetings were either paper sessions or symposia. However, it was difficult to distinguish the two because in both cases there was a series of short, 15-minute papers on a common subject and with a minimum discussion. The audience participation was much less than one would expect at an international meeting and probably stemmed from the brevity of the presentations.

The official languages of the congress were English, Russian, and German, although most papers, even those by the Russians and Germans, were presented in English. Simultaneous translation into the official languages was available at most sessions.

Because of the size of the congress, it is impossible to provide a thorough review of the proceedings. The sessions addressed all areas of psychology, with the emphasis clearly on cognitive processes. One of the most interesting and thoroughly presented cognitive research programs was that of Dr. Dietrich Dörner and his colleagues at Bamburg University, West Germany. Their work on individual differences in complex problem solving generated considerable discussion.

The research has involved both highly structured tasks like the Tower of Hanoi problem as well as more complex and ill-defined tasks representative of real-life problem solving. In the latter category is the task of managing a small town. The town exists, with all the complexities of a real town, as a computer model. The subject in carrying out his management interacts with the computer, asking questions and changing parameters. Thus he may ask about population and industrial growth, unemployment, and the tax rates. Based on this information he may decide to provide industrial tax incentives to attract industry and increase jobs.

Since there are growth variables in the model, it is necessary for the subject to act. However, the problem of "good" management is a polytelic task. Not only are there a multitude of goals, they are not all clearly defined nor all consistent For example, the industrial-growth policy has implications for environmental management and the need for social services.

In a series of experimental sessions, the subject manages the town's growth through a 10-year cycle. During experimental sessions, subjects were asked to think out loud as they planned and evaluated approaches to management. The verbal protocols were then analyzed to determine strategy differences between successful and unsuccessful managers. Basically, successful managers began by gathering a lot of general and specific information. They reserved most decisionmaking for later sessions when they had an overall view of the functioning and structure of the town. The protocols of the successful managers also showed more coherence and depth in the analysis, i.e., general orienting questions were related to a theme and specific orienting questions arose from the general ones. Dörner found unsuccessful managers to be "thematic vagabonders." While they pursued a theme in each session, they eventually began hopscotching with unrelated general and specific orienting questions. They asked more general and specific orienting questions, but made fewer decisions. Basically, they never went into a decision-making mode as the successful managers did in the later experimental sessions. Rather, they increased the number of specific orienting questions and never seemed to develop an image of the structure of the town system.

Dörner and his colleagues next looked at individual difference variables which might give rise to these strategy differences. In contrast to a considerable amount of other problem-solving research, they found that relevant world knowledge was unrelated to successful management, i.e., prior knowledge in town planning or complex systems did not predict success They also found intelligence test scores to be unrelated to success. However, success was related to a paper-and-pencil index of self-confidence. Based on this and other testing, Dörner and his colleagues propose that performance is a function of the effectiveness with which the individual can manage stress and anxiety. In this complex system, the subject frequently loses control of the situation. To the extent that he lacks self-confidence in his ability to regain control, anxiety and stress are created. The anxiety and stress, in turn, result in flight or thematic vagabonding.

The lack of a relationship between intelligence and problem solving has also been pursued by the Bamberg Laboratory. The Bamberg investigators have consistently found measures of intelligence and complex problem solving to be unrelated (r's ranging from .1 to .2). The tasks included, besides the town management, the Tower of Hanoi, the Tangram Puzzles, and other tasks requiring complex planning and complex decision problems. The intelligence tests included the Cattell Culture Free Test, the Raven's Progressive Matrices, and the IST and LPS batteries. They propose that the lack of a relationship is due to the fact that IQ tests generally assess only lower level cognitive and memory skills. Higher level cognitive abilities like goal selecting, balancing multiple goals, induction, and organizing multiple mental operations are not assessed. They also found that teacher's assessment of a student's ability is related to his intelligence as measured by intelligence tests, but not to his problem-solving skill. Thus, they argue that measurement efforts must begin to focus on problem-solving skill. Especially in the educational system, the focus on intelligence may in fact conflict with the development of problem-solving skills. (Thomas M. Duffy, Navy Personnel Research and Development Center, San Diego, CA)

NEWS and NOTES

BOLKESJØ WORKSHOP ON REMOTE MEASUREMENT OF UNDERWATER PARAMETERS

The first international meeting on the topic, "Remote Measurement of Underwater Parameters," took place 30 October through 1 November 1980 at Bolkesjø, Norway (110 km west of Oslo). The meeting was partially funded by ONR London. Approximately 70 scientists participated, from eleven different countries (Australia, Canada, Denmark, France, FRG, Italy, Netherlands, Norway, Sweden, UK and the US). Sponsored by the Space Activity Division of the Royal Norwegian Council for Scientific and Industrial Research (NTNF), the workshop's main objective was to convene an international field of scientists to inform/discuss/compare/collate the current status of capabilities in the entitled research. The organizing committee consisted of Dr. Bjørn Landmark (NTNF), Dr. Ola Johannessen (Geophysics Institute, University of Bergen) and Mr. Hans Dolezalek (ONR).

The first day saw seven invited papers covering such diverse technological domains as Raman backscatter, ocean acoustic tomography, spaceborne altimetry, laser-induced fluorescence and brillouin scattering. Fifteen contributed papers were given the second day with a wide range of related topics, such as ocean fronts, Coastal Ocean Dyanmics Application Radar (CODAR), synthetic aperture radar (SAR), laser bathymetry, and numerical ocean forecast modeling. The final day was set aside for individual working groups to meet and draft recommendations for future research efforts in the remote measurement of the following underwaters parameters: bathymetry, water column characteristics and ocean currents. These results, plus conclusions and abstracts of all papers will be widely promulgated in the near future. Almost all participants agreed that the overall workshop was a resounding success. (C.H. Spikes)

COS-B FIVE YEARS IN ORBIT

On August 9 1980, COS-B, the first satellite of the European Space Agency (ESA), completed 5 years of successful operation. It was designed for a minimum operational life of 1 year and provisioned for two years with on-board consumables.

With its single 120 kg experiment, which can be considered as a "gamma-ray telescope," COS-B has carried out the

first complete detailed survey of the Milky Way in high-energy gamma rays, providing a new insight into the structure of our Galaxy and the mechanisms of cosmic gamma-ray production. At the same time, a score of new gamma ray sources have been discovered. Many of these have not been readily identifiable with known celestial objects, which has stimulated specific new investigations in the fields of X-ray and radio astronomy. The few which have been identified include the quasar 3C273, the most distant source of gamma radiation thus far discovered.

The brightest "gamma-ray star" is the Vela pulsar, three times as bright as its closest rival. It and the Crab pulsar have been investigated in great detail by COS-B, providing major contributions to the study of this important class of object.

The payload was designed and supplied by a collaboration of research groups from the Centre d'Etudes Nucléaires de Saclay, the Max Planck Institut für Extraterrestrische Physik, the Universities of Leiden, Milan, and Palermo, and ESA Space Science Department.

The satellite was developed by the CESAR consortium, led by Messerschmidt-Bölkow-Blohm with industrial firms of seven ESA member states (Belgium, Denmark, France, Germany, Italy Spain, United Kingdom).

FRANCE EXPANDS UNDERSEA RESEARCH PROGRAM

A new boost is to be given to France's ocean-research program. Compared with 1980, the budget for the coming year is to be increased by 30 percent to $40 million.

The increase is to meet three new priorities in the area of ocean-bed exploration. The first will be the construction of a mini reconnaissance submarine capable of reaching depths of up to 20,000 feet. Additional resources are to be devoted to research into marine pollution. A second priority will be exploration of the sea-bed to locate new sources of oil and a third priority will be an exploration for metal nodules in the Pacific.

Though ambitious, these programs are running into difficulties as a result of the decision earlier this year to split responsibility for ocean research between different ministries. Fishing and aquaculture come under the aegis of the ministry of transport, and programs involving mineral and energy resources fall under the ministry of industry. The ministry of higher education is to finance those areas not covered by the other two.

This division of responsibilities is causing serious difficulties by emphasizing the separation between applied research, funadmantal research and development work. This is a particularly large problem in the field of oceanographic exploration which relies heavily on large-scale equipment. It has also prevented the emergence of a coherent overall research strategy.

Earlier this year when the policy was first outlined, hopes were expressed that the national center for ocean development (CNEXO) would act as a major liaison body but so far this has not happened. The ministry of industry, for example, has refused to fund the deep-sea exploration program for oil reserves, leaving this to the ministry of higher education. The ministry of transport has so far shown itself unwilling to unveil its future programs.

RADIATION MACHINE INAUGURATED

The world's first dedicated machine to use synchrotron radiation to probe the fine structure of matter was officially inaugurated recently in the UK.

The $11 million synchrotron radiation source (SRSO) at the Science Research Council's (SRC) Daresbury Laboratory will produce electromagnetic radiation, from X-rays to radio waves, generated by circulating beams of high energy electrons. The highly intensive radiation will then be used to carry out research in physics, chemistry, biology, and material studies.

It is hoped that when operating at maximum capacity, the source will supply 50 experimental stations including those carrying out investigations of molecules and chemical reactions, cells and viruses, solid surfaces and liquids, as well as semiconducting and magnetic materials.

The synchrotron radiation source, which has been built from the remnants of Daresbury's old NINA accelerator, is expected to be of immense benefit to industry. For example, the research pursued by academics on the SRS will find many applications in industry. In addition, industrial research teams will be able to participate directly in the research program.

It should be noted, however, that the rate of progress of research using synchrotron radiation has been hindered by recent cuts by the UK Government in the country's science budget which have forced the SRC to reduce development of experiments for the machine.

DR. WALTER MARSHALL TO HEAD UK ATOMIC ENERGY AUTHORITY (UKAEA)

Dr. Walter Marshall is to succeed Sir John Hill as chairman of the United Kingdom Atomic Energy Authority. He takes up the 5-year appointment on 22 February 1981.

Hill, who has been chairman for 13 years, will continue as part-time chairman of British Nuclear Fuels, which controls the Windscale reprocessing plant and the Radiochemical Center.

The appointment of Marshall, who has been the deputy chairman since 1975, reinforces the UK Government's preference for continuing the British nuclear power program with the American-designed pressurized-water reactor (PWR) in place of the British advance-gas-cooled system.

Marshall became convinced of the superiority of the PWR over the British design in 1976 after completing a 4-year study of the safety of the pressure vessel containing a PWR radioactive core. Since then, he has been one of the PWR's most dedicated advocates. The position of chairman of the UKAEA makes Marshall the chief advisor on nuclear energy to the UK Secretary of State for Energy.

The UK Government plans to hold a public inquiry into the building of the first PWR, now expected to be ordered in 1983, at the earliest.

European Visitors to the US Supported by ONR London

Visitor	Affiliation	Navy Lab./Org. to be Visited
	MAY	
Dr. D.E. Packham	Univ. of Bath, School of Materials Science, Bath, UK	NSWC, White Oak

ONRL REPORTS

C-5-80

SIMULATION '80 SYMPOSIUM by Richard E. Nance

This report of the Simulation '80 Conference held in Interlaken, Switzerland on 25-27 June 1980, focuses on the methodological and technological sessions. The report is divided into four topical areas: (1) methodological issues, (2) computing hardware, (3) computing software, and (4) simulation applications. A concluding summary draws a brief comparison between the current research interests in Europe and the US.

R-4-80

Marine Science in Southern Wales by Wayne V. Burt

Marine science programs are concentrated in the cities of Swansea and Cardiff. Marine research is being carried out in the departments of oceanography, chemistry, chemical engineering, economics, geography, metallurgy and materials science, mechanical engineering, civil engineering, geology, and zoology at the University College of Swansea. The Department of Maritime Studies at the University College of Wales in Cardiff has research and instructional programs in maritime technology, maritime geography, maritime commerce, sea law and policy, shipping economics, marine geology, and marine meteorology. Some deep sea and Bristol Channel seismic research is also underway in the Geology Department of the University College of Wales in Cardiff.

SUBJECT INDEX FOR VOLUME 34, ESN ISSUES 1 THROUGH 12, 1980

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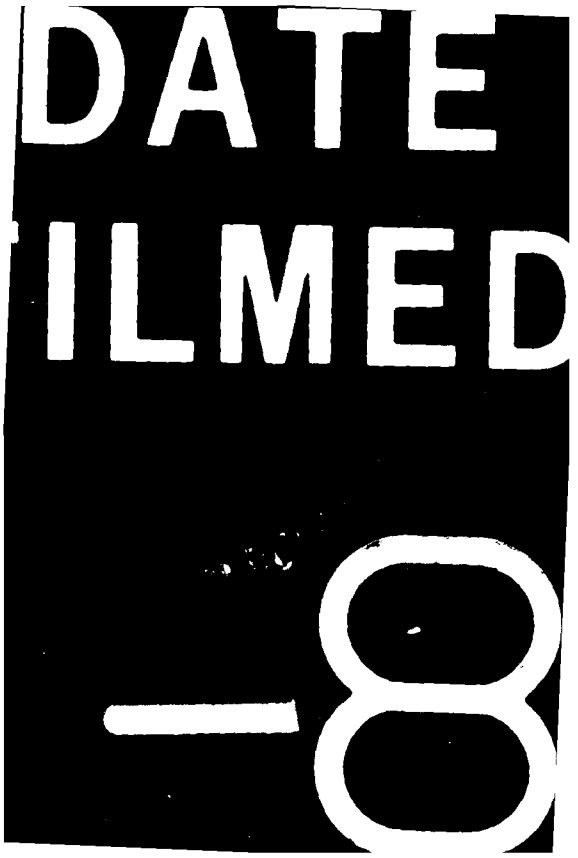
PHYSICAL SCIENCES

PSYCHOLOGICAL SCIENCES

SYSTEMS ANALYSIS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